TM 9-731A

RESTRICTED

WAR DEPARTMENT

TECHNICAL MANUAL

MEDIUM TANKS M4 AND M4A1

NOVEMBER 14, 1942

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TECHNICAL MANUAL
No. 9-731A

WAR DEPARTMENT
Washington, November 14, 1942

MEDIUM TANKS M4 AND M4A1

Prepared under the direction of the
Chief of Ordnance

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* This manual supersedes TB-757-2, July 10, 1942.

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PART ONE—Operating Instructions

Section I

INTRODUCTION

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1. PURPOSE AND SCOPE.

a. These instructions are published for the information and guidance of the personnel of the using arms charged with the operation, maintenance, and repair of this materiel. They contain descriptions of the major units and their function in relation to the other components of the tank, as well as instructions for operation, inspection, minor repair, and unit replacement. The instructions contained in this manual apply to the Medium Tank M4 and Medium Tank M4A1. The M4 Tank has a welded hull; the M4A1 Tank has a cast hull. Except for this difference in design and construction, these two tanks are similar and the operating instructions contained in this manual apply to both tanks.

2. CONTENT AND ARRANGEMENT OF MANUAL.

a. Sections I through IX contain information chiefly for the guidance of operating personnel. Sections X through XXIX contain information intended chiefly for the guidance of personnel of the using arms doing maintenance work.

3. REFERENCES.

a. Section XXX lists all standard nomenclature lists, technical manuals, and other publications for the materiel described herein.

4. DESCRIPTION (figs. 1, 2, 3, 4, 5, 6, 7, and 8).

a. These medium tanks are armored, track-laying vehicles designed to give greater protection to the crew and more effective firing power than previous model medium tanks. The thickness of the front section of the hull varies from 1½ inches to 3 inches. The M4 has a welded hull; the M4A1 has a cast hull; both have cast turrets. Both turret and hull are so curved as to present little opportunity for a direct hit on a flat surface from any angle. This tank provides the tactical advantage of a lower silhouette than previous medium tanks. This also results in a lowered center of gravity, making it more difficult for the tank to tip over.

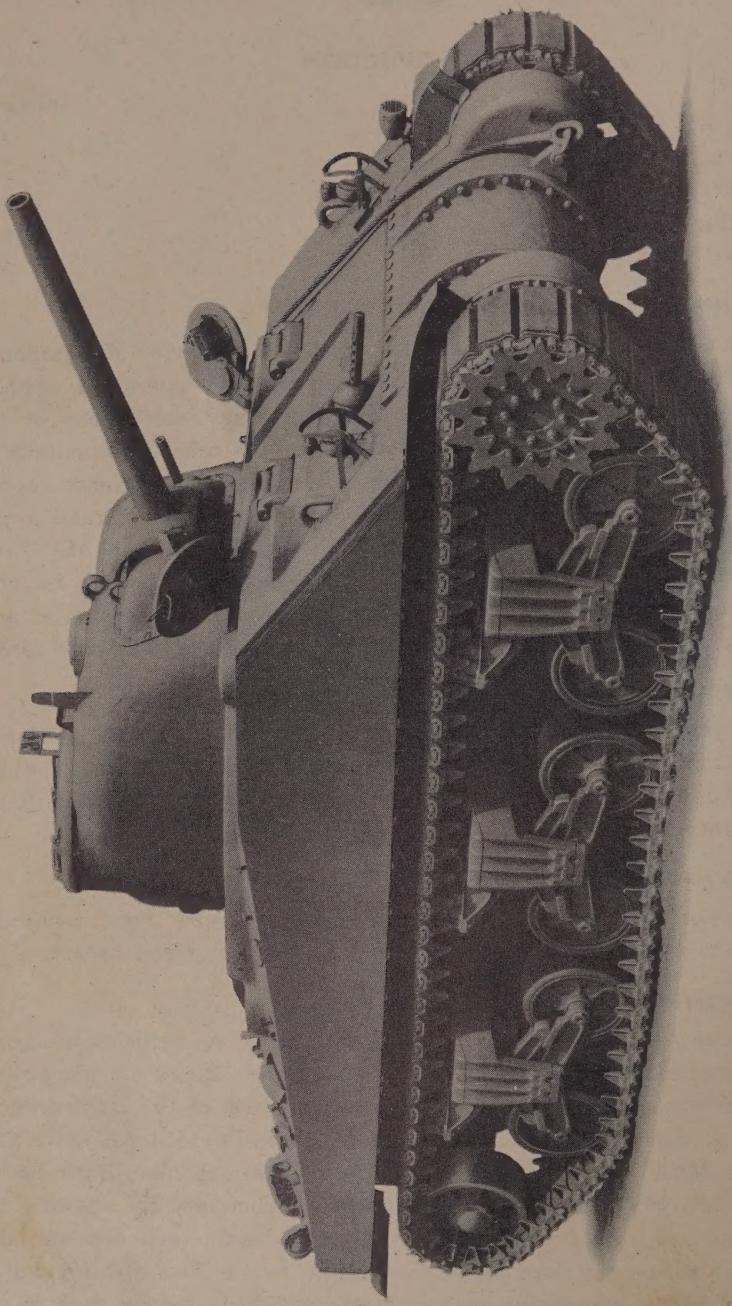

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Figure 1—Three-quarters—Right Front View of Medium Tank M4

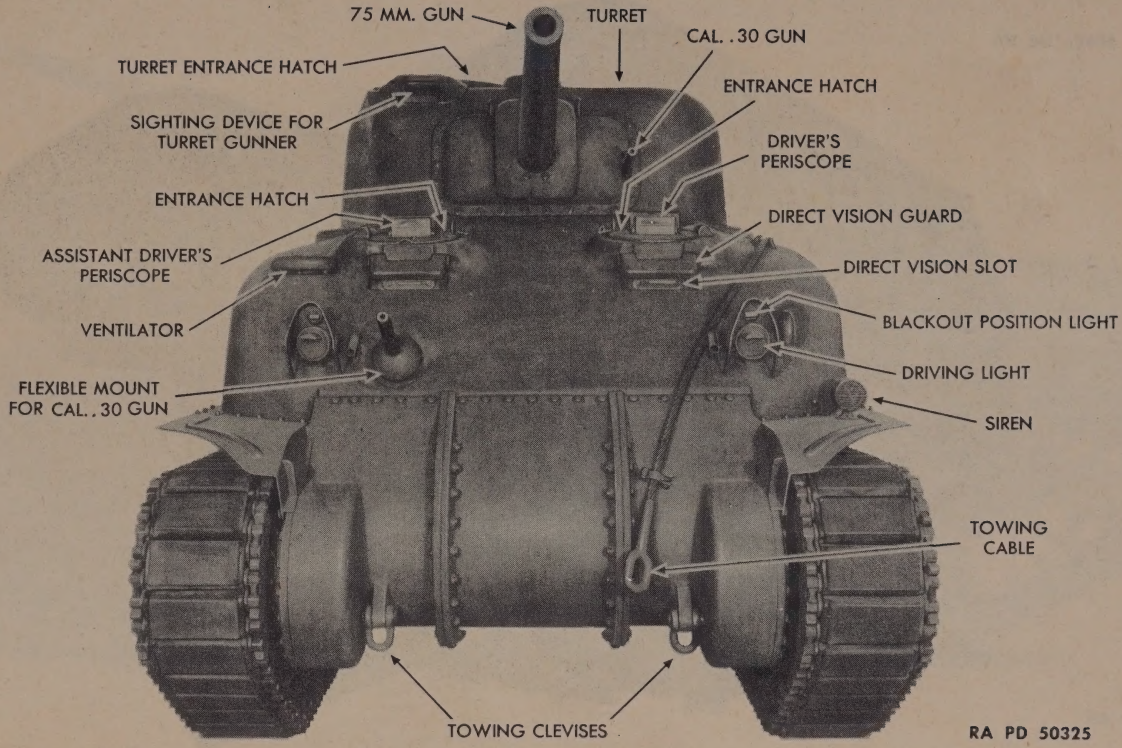

Figure 2—Front View of Medium Tank M4A1

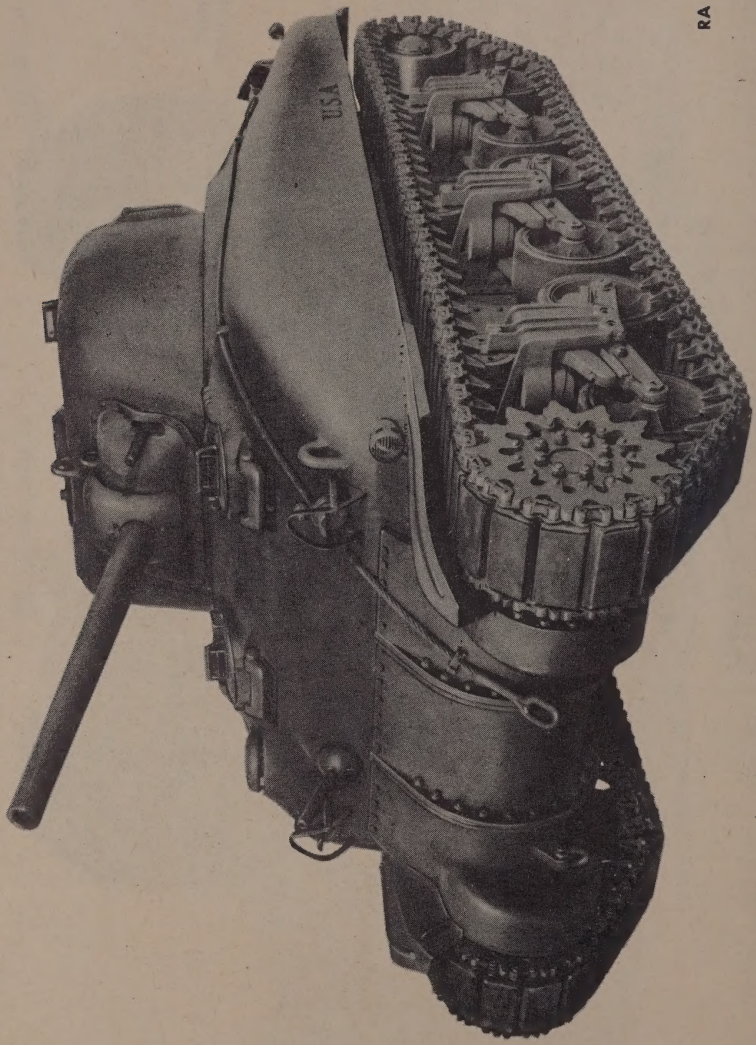

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Figure 3—Three-quarters—Left Front View of Medium Tank M4A1

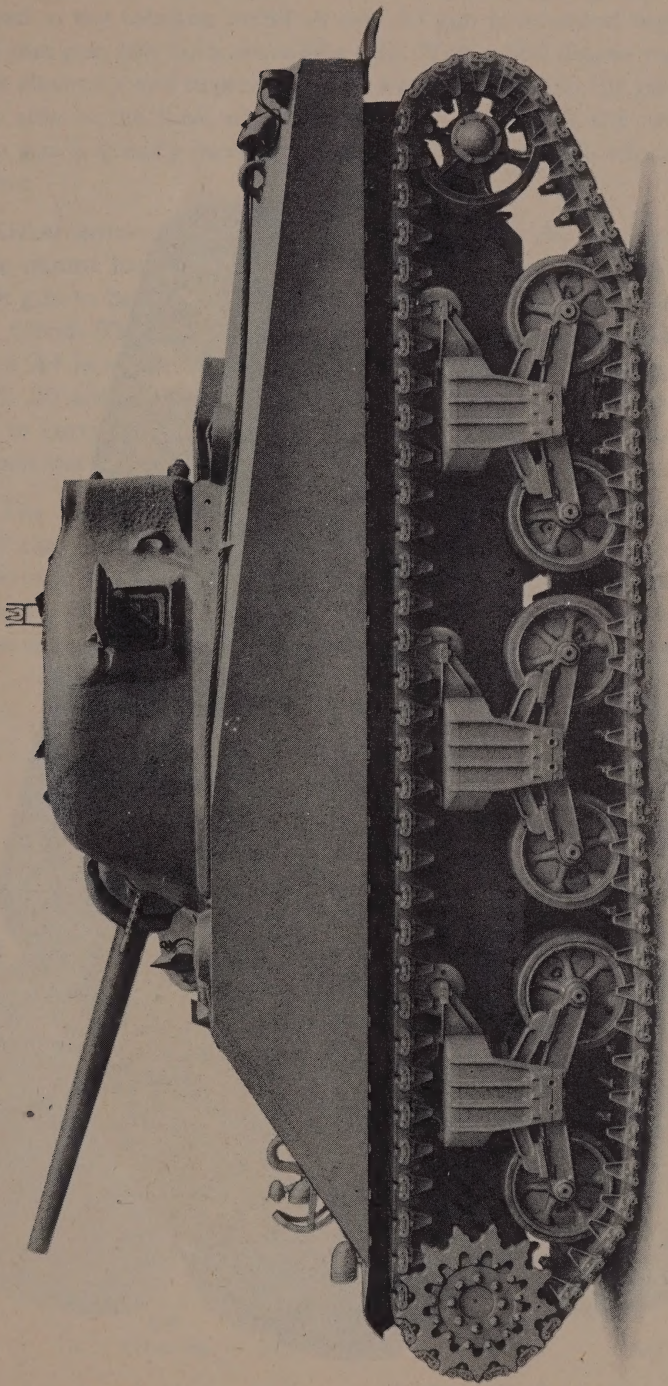

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Figure 4—Left Side of Medium Tank M4

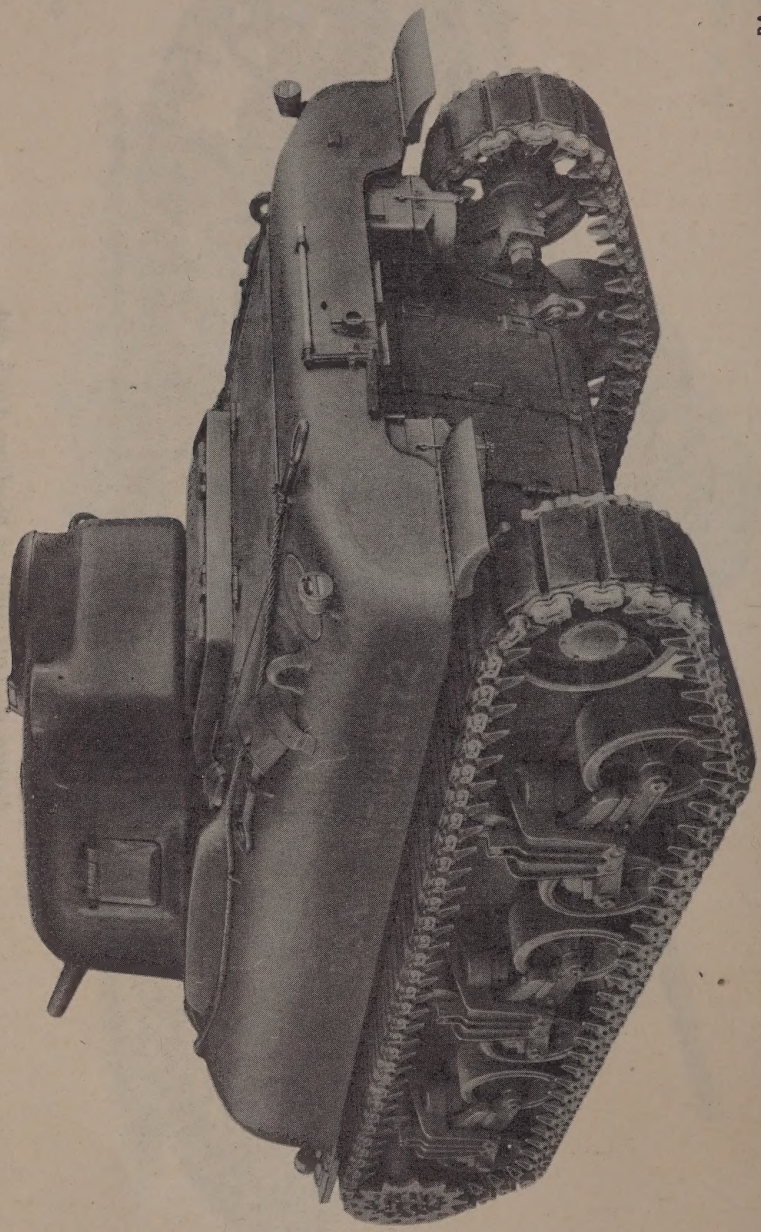

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Figure 5—Three-quarters—Left Rear View of Medium Tank M4A1

INTRODUCTION

b. The principal armament of these medium tanks is the 75-mm gun mounted in the rotating turret. A cal. .30 gun is mounted together with the 75-mm gun and both move as a unit. With a 360 degree traverse and greater elevation and depression than was possible with the gun mounted on the side of the tank, as in the Medium Tank M3, the range of the 75-mm gun is greatly increased and its fire power made effective in any direction.

c. Other armament in the tank includes a cal. .30 machine gun in a flexible mount located in the right bow of the tank and a cal. .50 antiaircraft gun to be used in a bracket mount on top of the revolving hatch of the turret. This gun is being replaced by a Machine Gun, Cal. .30, M 1919 A4 in an antiaircraft mount. Later production tanks will carry the cal. .30 antiaircraft gun. A clip is mounted in the top rear of the turret to carry a cal. .45 submachine gun which can be used through the pistol port located in the left rear side of the turret.

d. The tank crew consists of five men. The driver sits at the left bow of the tank, to the left of the transmission. The assistant driver's position is in the right bow, to the right of the transmission and directly behind the cal. .30 machine gun. The tank commander is stationed at the rear of the turret, just to the right of the shoulder guard of the 75-mm

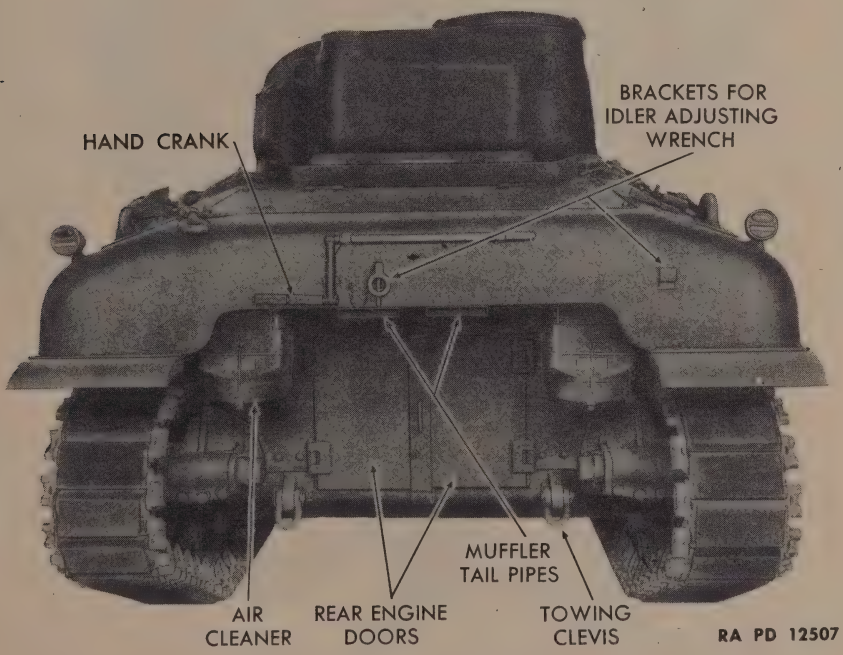

Figure 6—Rear View of Medium Tank M4A1

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Figure 7—Right Side of Medium Tank M4A1

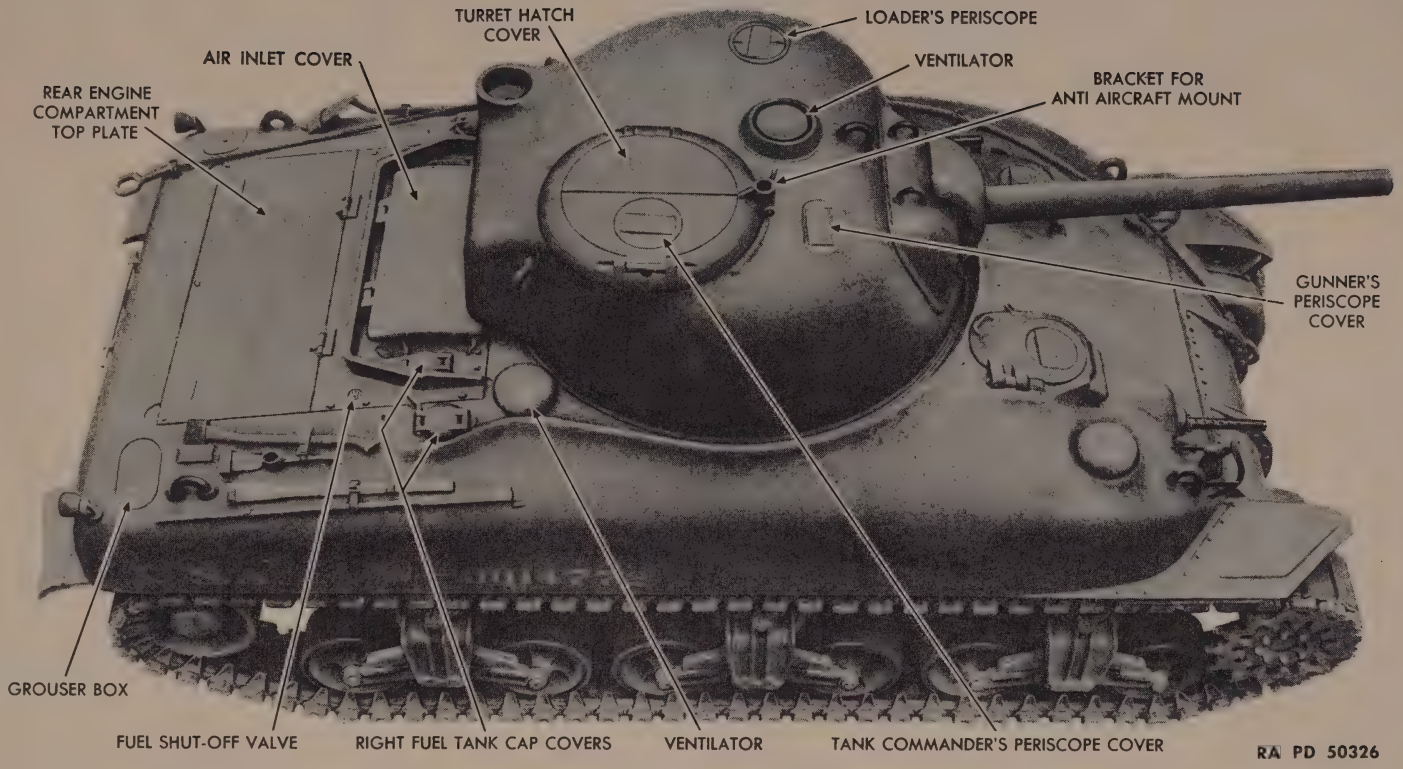


Figure 8—Top View of Medium Tank M4A1

gun, and almost directly behind the gunner. The 75-mm gunner's station is in the right front just ahead of the tank commander. The loader's station is to the left of the 75-mm gun.

e. Access to the tank is provided through the two hatches in the bow and the revolving hatch in the turret. For use in an emergency an escape hatch is provided in the tank floor, directly back of the assistant driver.

f. When all hatches are closed, indirect vision is provided for each member of the crew by means of periscopes. With the exception of the gunner's periscope, these vision devices are mounted so that they can be tilted up or down and rotated through a 360 degree traverse. The gunner's periscope is synchronized with the gun, contains a telescopic sight, and changes its line of sight only if the gun is elevated or depressed or the turret rotated. For emergency use, the driver and assistant driver are also provided with direct vision through a narrow slit in the direct vision guard in the front armor plate. Two additional M6 Periscopes will replace these slits in later production models.

g. The tank is powered by a 400-horsepower, nominal 9-cylinder radial aircraft-type engine. Access to the engine is provided through a hinged engine compartment top plate, the rear engine doors, and the inspection plate located beneath the engine. Horizontal mufflers, running from front to rear under the engine compartment top plates, reduce engine noise considerably below that of previous model medium tanks. The air cleaners are mounted at the rear and outside the engine compartment for easier servicing. An air inlet cover in the front engine compartment top plate gives access to the fan compartment. The tank has four fuel tanks, two vertical tanks and two large sponson tanks, located at the right and left front of the engine compartment. They are filled through four caps located on the top of the hull to the right and left rear of the turret.

h. An auxiliary generator set is located in the left rear of the fighting compartment. Its purpose is to provide an additional source of electrical power and also to provide heat for the engine compartment in cold weather.

i. The tank is equipped with radio for intertank communication and with an interphone system for communication between the tank commander and members of the crew.

5. TABULATED DATA.

a. General.

Weight without armament, fuel, and crew	55,600 lb
Weight fully equipped	Approximately 30 tons

INTRODUCTION

Ground pressure ..... 12.9 lb/sq in.
Over-all width ..... 8 ft 7 in.
Ground clearance ..... 17 in.
Tread (center to center of tracks) ..... 83 in.
Over-all height ..... 8 ft 9 in.
Over-all length ..... 18 ft 6 in.

b. Engine (Continental or Wright R-975).
Rated horsepower (black name plate) (R-975-EC2) 400
(blue name plate) (R-975-C1) 380
Number of cylinders 9

c. Weights.
Weight of engine w/accessories ..... 1,370 lb
Weight of hull ..... 20,000 lb
Weight of turret ..... 6,180 lb
Weight of power train (including transmission) ..... 7,690 lb

d. Armament.
1 cal. .30 machine gun in assistant driver's compartment in flexible mount.
1 75-mm gun and 1 cal. .30 machine gun mounted parallel to each other in turret.
1 cal. .50 machine gun, antiaircraft, for bracket mount on top of turret.
1 cal. .30 machine gun, antiaircraft, for bracket mount on top of turret.

e. Ammunition Stowage Facilities.
90 rounds, 75-mm ammunition
300 rounds, cal. .50 ammunition (removed if cal. .50 machine gun is replaced)
8,000 rounds, cal. .30 ammunition
600 rounds, cal. .45 in 30-round clips
12 hand grenades

f. Seats, body supports, and safety belts are provided for each of the five members of the crew.

g. Portions of the interior are padded with Korosea (fireproof) needed to protect the crew against bumps.

h. Communication.
Radio ..... SCR 508 (FM) sending and receiving and associate interphone equipment. Voice 10-15 miles
Intra-tank ..... Interphone system

MEDIUM TANKS M4 AND M4A1

i. Armor Thickness.

Front	3 in.
Rear	1¼ in.
Sides	1¾ in.
Top, hull	1½ in.
Bottom	½ in.

j. Turret. Cast armor 2¼ inches thick, 360 degrees traverse.

k. Crew. 5 men.

l. Tracks. Rubber block.

Track shoe width	16 in.
Track pitch	6 in.
Ground contact	3,432 sq in.
Number of blocks/track	79

m. Fuel and Oil.

Fuel capacity	185 gal
Number of miles without refueling (8 hr at 18 mph)	144
Octane rating of fuel (block name plate engine) (R-975-EC2)	91 or higher
(blue name plate engine) (R-975-C1)	80 or higher
Oil consumption (approximate)	2 qt/hr
Engine oil capacity	36 qt
Lubricants	See lubrication chart

n. Performance.

Maximum sustained speed on hard road	19.3 mph
Expected cross-country speeds for various terrains	4 to 20 mph
Maximum allowable engine speed	2,400 rpm
Maximum vehicle speed on smooth road	24 mph
Minimum engine idling speed	800 rpm
Maximum grade ascending ability	30 deg
Maximum grade descending ability	30 deg
Maximum width of ditch tank will cross	7 ft 5 in.
Maximum verticle obstacle, such as a wall, that the tank will climb over	18 in. without grousers
Maximum fording depth (at slowest forward speed)	36 in.
Drawbar horsepower	Maximum of 227.5 in second gear on concrete at 2,000 rpm

Section II

OPERATION INSTRUCTIONS AND CONTROLS

	Paragraph
General information on controls	6
Inspections before starting engine or tank	7
Engine starting and warm-up	8
Tank inspections during engine warm-up	9
Operating the tank	10
Stopping the engine	11
Cold weather operation	12

6. GENERAL INFORMATION ON CONTROLS.

a. Position of Driver. The driver sits on the left side of the front compartment directly under the left front hatch. The driver's seat is adjustable for height and can be moved forward or backward to the most comfortable driving position.

b. Steering Levers (fig. 9). Two steering levers provided with rubber grips are mounted on the floor of the vehicle, directly ahead of the driver's seat (fig. 9). To steer the vehicle, pull the steering lever on the side toward which it is desired to turn. Pulling back either one of the levers slows down the track on that side, while the speed of the other track is increased. Thus the vehicle turns with power on both tracks at all times.

c. Accelerator and Hand Throttle (fig. 9). A foot accelerator pedal is located to the right of the steering levers, convenient to the driver's right foot. In conjunction with the foot pedal, a hand-operated throttle is provided, which is mounted on the final drive housing and to the right of the steering levers.

d. Brakes.

(1) SERVICE BRAKES. Pulling back simultaneously on both steering levers slows down or stops the driving sprockets, depending on the effort applied, and thus slows or stops the tank.

(2) PARKING BRAKE. The parking brake lever is located on the right side of the driver, at the back of the transmission. *It is a transmission-type brake, and should never be used for any purpose other than parking.*

e. Clutch. The clutch pedal is located to the left of the steering levers, convenient to the driver's left foot. To permit shifting of gears, the clutch is disengaged by depressing the clutch pedal. When the pedal is depressed, power from the engine to the power train is disconnected.

MEDIUM TANKS M4 AND M4A1

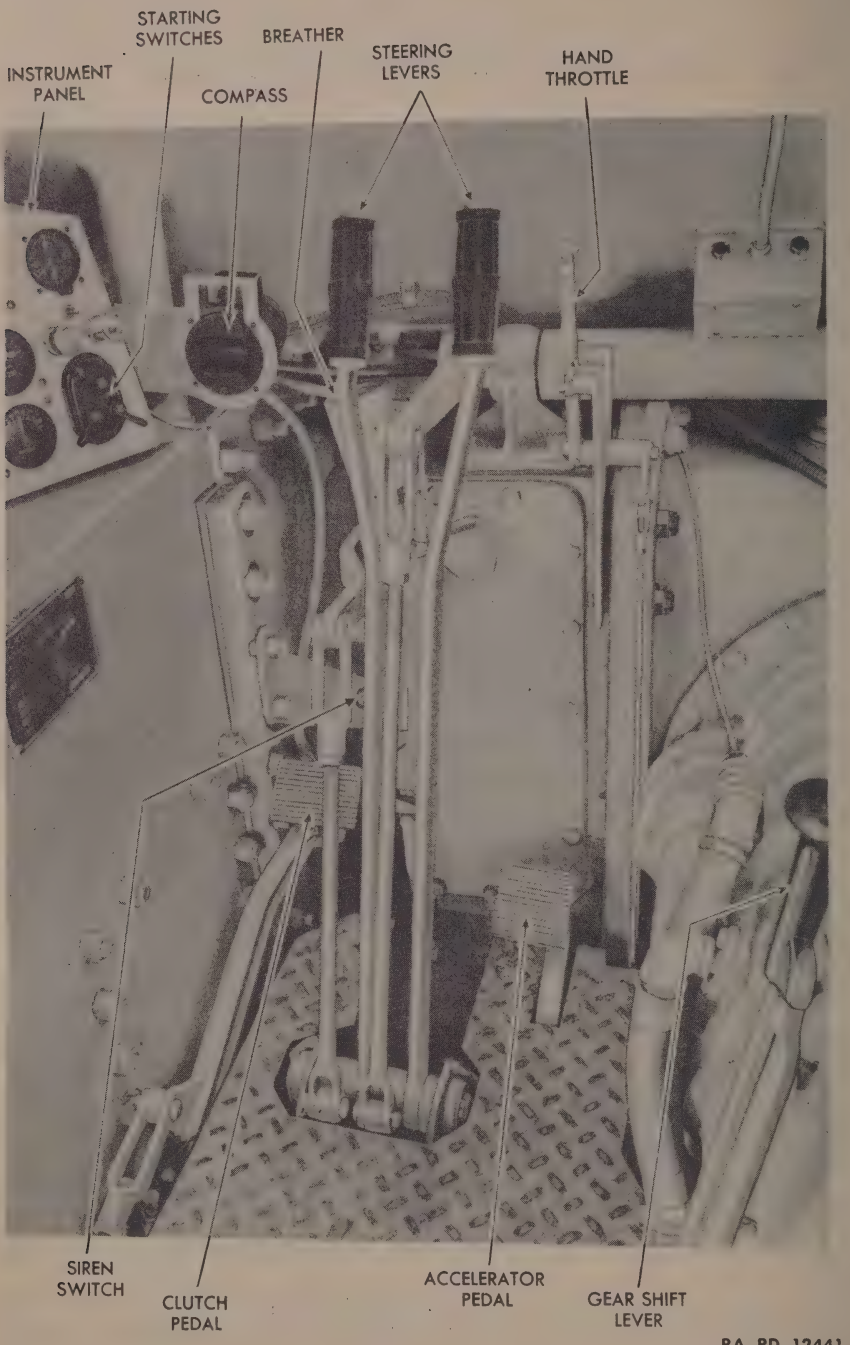


Figure 9—Driver's Controls in Medium Tank M4 and M4A1

OPERATION INSTRUCTIONS AND CONTROLS

f. Gear Shifting (fig. 10). Shifting of gears in the transmission for speed changes is accomplished by the gearshift hand lever, located on the transmission to the right of the driver. The positions of the gearshift lever for the various speeds are shown in the diagram (fig. 10). The gearshift lever is equipped with a latch which prevents accidental shifting into first speed or reverse. The latch must be released by pressing down the button on top of the lever before shifting into first speed or reverse.

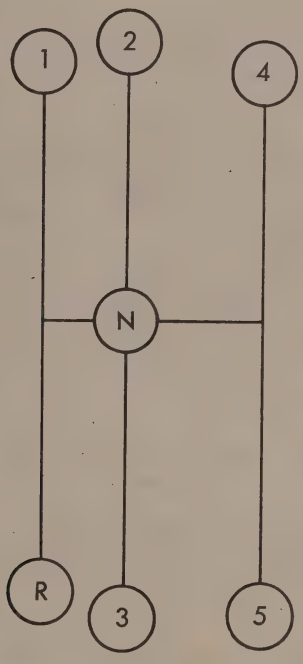


Figure 10—Shift Lever Positions

g. Instrument Panel (fig. 11). The instrument panel is located to the left of the driver, at the front of the left sponson. It carries the fuel gage, speedometer, engine hour meter, tachometer, engine oil temperature gage, engine oil pressure gage, transmission oil temperature gage, ammeter, voltmeter, ignition and starter switches, light switches, fuel cut-off switches, oil dilution switch, clock, and a series of circuit breaker reset buttons for the principal circuits. A compass is bracket-mounted at the left, in front of the driver.

h. Siren Control. The foot-operated siren button is located on a plate just above and to the right of the clutch pedal, within easy reach of the left foot of the driver.

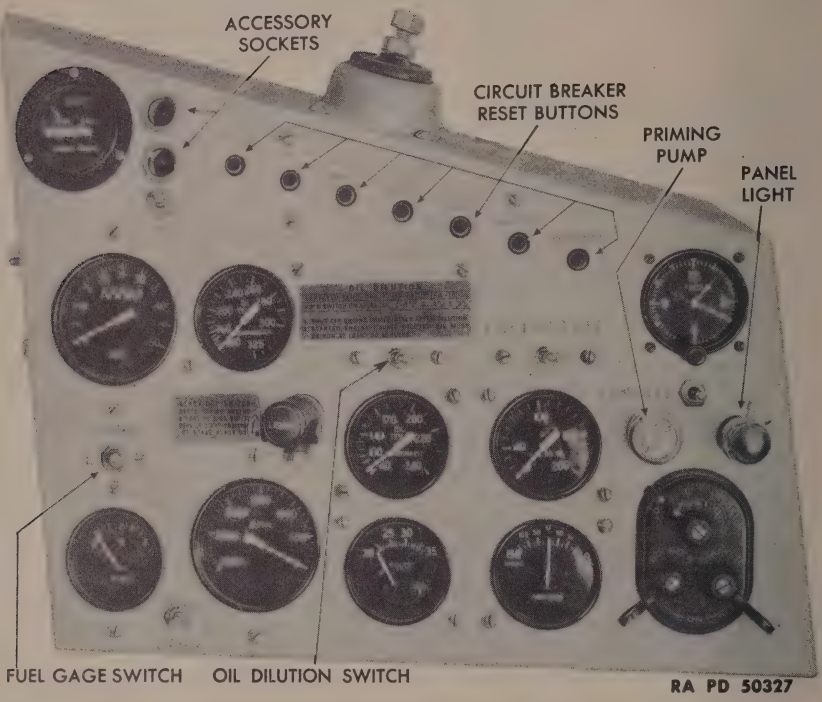


Figure 11—Detail of Instrument Panel on Medium Tank M4 and M4A1

i. Stop Light Switches. Stop lights are operated by two switches connected to the steering brake arms and are turned on only when both steering levers are pulled back.

7. INSPECTIONS BEFORE STARTING ENGINE OR TANK.

a. Before the engine is started or the tank put into operation, a careful and complete inspection should be made, covering the steps indicated below. The various parts of the inspection will be assigned to different crew members by the tank commander. It is the responsibility of the tank commander to see that each inspection is properly made and checked on the tank commander's report.

b. Equipment. The following is a list of the tools regularly needed for the prestarting inspection:

CAN, oil, filled with OIL, engine, SAE10
PLIERS
SOLVENT, dry-cleaning
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end or socket, 1 1/8-in.
WRENCH, socket, 7/8-in.

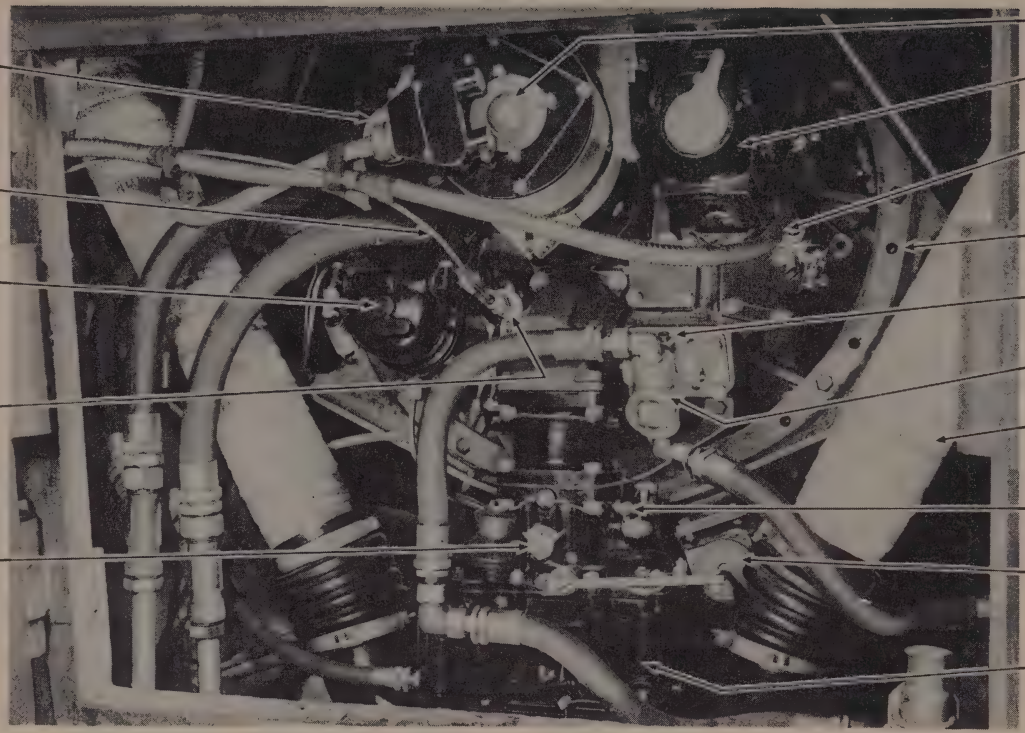


Figure 12—Engine—Through Rear Engine Doors

c. **Procedure.**

(1) OPEN REAR DOORS TO ENGINE COMPARTMENT (fig. 12).

WRENCH, open-end, 1⅛-in.

Using a 1⅛-in. open-end or socket wrench, remove the four cap screws holding the doors closed. Open the doors. Note any presence of gasoline fumes or evidence of leaking fuel or oil lines, as shown by oil or fuel on the floor of the engine compartment or around the carburetor or fuel and oil pumps.

(2) TURN HANDLES OF FUEL AND OIL FILTERS (fig. 13). Turn the cleaning handles of the oil and fuel filters one complete turn in either direction. This cleans the dirt from the edges of the filters. Failure to turn the handles a complete turn each day will allow filters to clog and permit unfiltered fuel or oil to bypass directly into the engine.

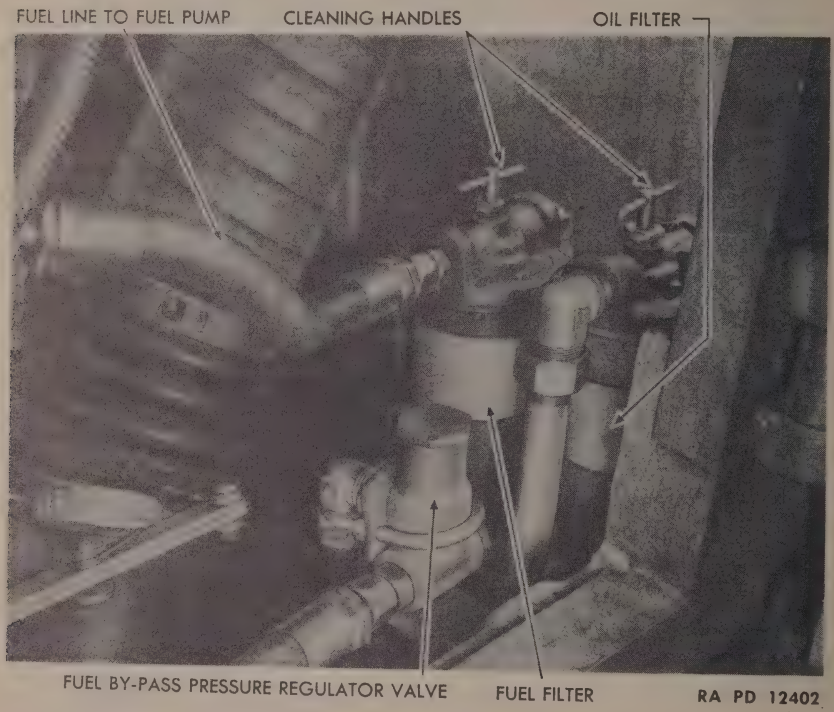


Figure 13—Location of Fuel and Oil Filters

(3) CHANGE OIL IN AIR CLEANERS (figs. 6 and 14).

SOLVENT, dry-cleaning

Unless the tank has been operating in wet weather, snow, or under unusually dust-free conditions, the oil in the air cleaners should be changed daily. Under dusty conditions it may be necessary to service

the air cleaners even more frequently. To change the oil, first loosen the four wing nuts on the latching bolts sufficiently to allow the bolts to be pulled free of the latches. This releases the bottom section of the air cleaner, including the oil reservoir and the baffle. Remove the two wing nuts holding the lower filter section in place and remove the section. Remove the baffle from the oil reservoir, pour out the oil and scrape out the dirt. Clean the lower filter section with SOLVENT, dry-cleaning, and reinstall it in place on the filter. Clean the baffle and place it in the oil reservoir. Fill the oil reservoir up to the oil line indicated on the baffle, with used crank case oil. Lift the reservoir into place on the filter, hook the latching bolts and wing nuts beneath the latches, and tighten into place. Repeat the operation on the other air cleaner.

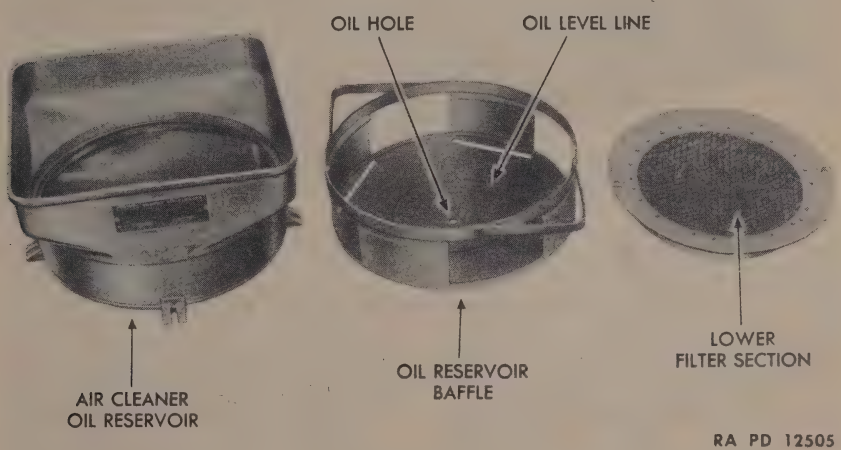


Figure 14—Air Cleaner Parts Requiring Daily Service

(4) REMOVE AND CLEAN CARBURETOR SCREEN (fig. 15).

PLIERS
WRENCH, open-end, $1\frac{1}{16}$-in.
SOLVENT, dry-cleaning

Using a pair of pliers, remove the locking wire from the nut on the bottom of the screen. Then, using an $1\frac{1}{16}$-inch open-end wrench, remove the screen (fig. 15). Wash screen with SOLVENT, dry-cleaning, being sure that all trace of dirt is removed. Replace screen, being careful not to tighten it too tightly to avoid spreading or otherwise injuring the lead gasket. Replace lock wire.

(5) REMOVE AND CLEAN OIL PUMP FINGER STRAINER (fig. 12).

SOLVENT, dry-cleaning
WRENCH, socket, $\frac{7}{8}$-in.
WRENCH, open-end, $\frac{5}{8}$-in.

It is not necessary to clean the oil pump finger strainer daily, but

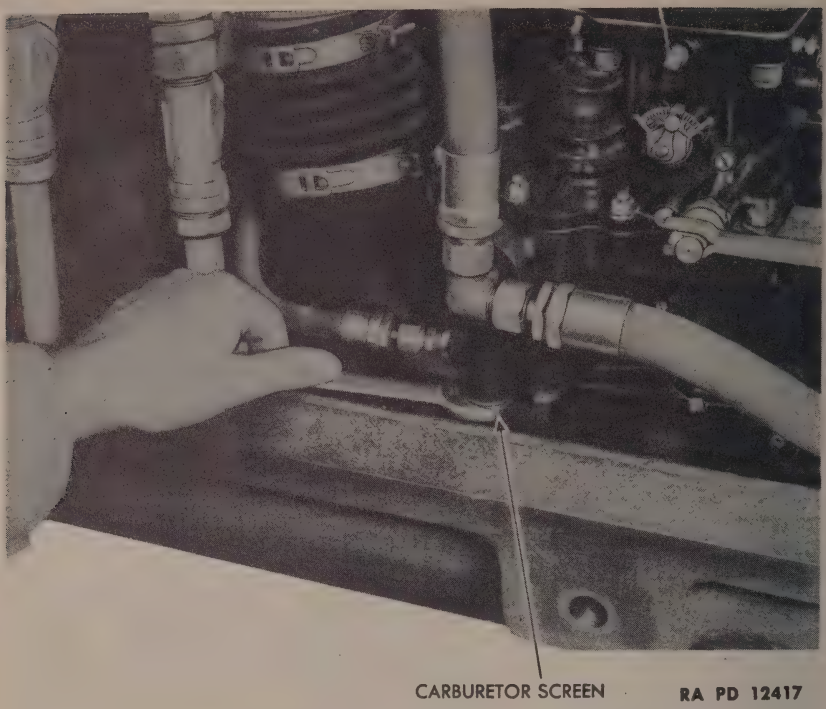


Figure 15—Removing Carburetor Inlet Screen

this operation should be performed after every 15 hours of operation. Using a ⅝-inch open-end wrench, remove the oil pump temperature gage line and cylinder. With a ⅞-inch socket wrench, remove the reducing nipple and the retainer nut (with copper gaskets for each). Remove the spring and pull out the strainer. Wash strainer in SOLVENT, dry-cleaning. Clean the spring and retaining nut. Reinstall strainer, insert spring, and screw retainer nut into place. Tighten the nut with a ⅞-inch socket wrench. Install the reducing nipple and tighten. Install the oil pump temperature gage cylinder and line and tighten into place with a ⅝-inch open-end wrench.

(6) LUBRICATING CLUTCH RELEASE BEARING AND CHECKING CLUTCH BEARING CLEARANCE (figs. 16 and 17).

CAN, oil, containing OIL, engine, seasonal grade.

Remove the lock pins from both sides of the air inlet cover and raise the cover. Lubricate the clutch release bearings and check the clearance (fig. 17). If the clutch bearing is too close to either the front or rear clutch flanges, it will be necessary to adjust the free play in the clutch linkage (fig. 18), as indicated in the following step.

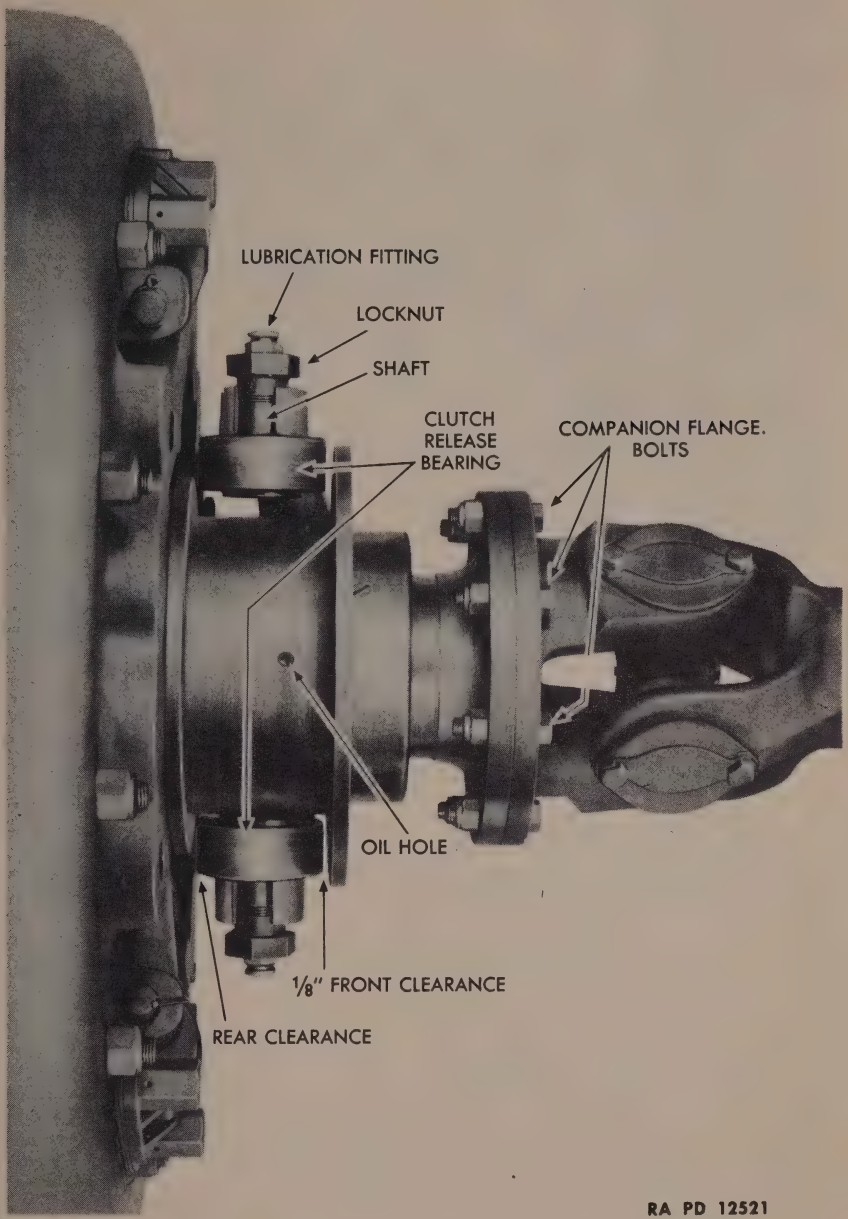


Figure 16—Top View of Clutch Release Bearings

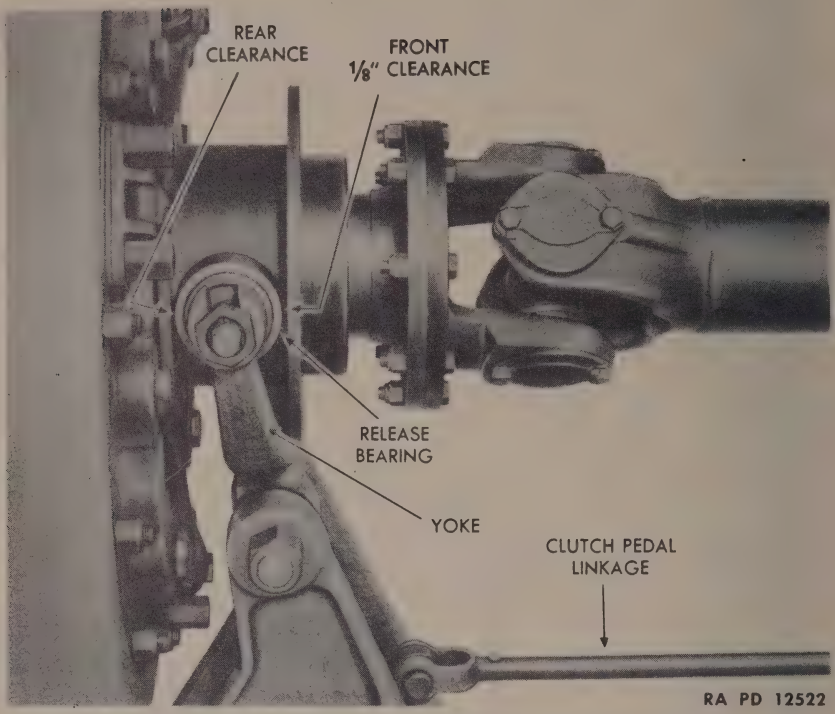


Figure 17—Side View of Clutch Release Bearings

(7) Adjustment of Clutch Linkage Free Play (fig. 18).

PLIERS
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 25/32-in.
WRENCH, open-end, 1-in.

This operation is ordinarily done by the driver. Using a pair of pliers, remove the cotter pin from the clutch pedal clevis pin. With a 1-inch open-end wrench, loosen the locking nut on the clevis. Remove the clevis pin and turn clevis clockwise to shorten the linkage and provide more free play or more clearance between the bearings and the front flange of the clutch throwout sleeve. Turn the clevis in or out to make the clearances between the bearing and the front flange 1/8 inch which will give the rear flange clearance approximately 1/8 inch. **NOTE:** Emergency adjustment of clutch free play may be made by adjusting the stop bolt located directly below the clutch pedal clevis. Turning the bolt *down* moves the clutch release bearings toward the front flange. Raising the bolt has the reverse effect. In making the adjustment, loosen the locking nut, using a 25/32-inch open-end wrench. Then adjust the bolt with a 3/4-inch open-end wrench. *This is an emergency adjustment. Proper adjustment should be made on the clutch pedal clevis at the*

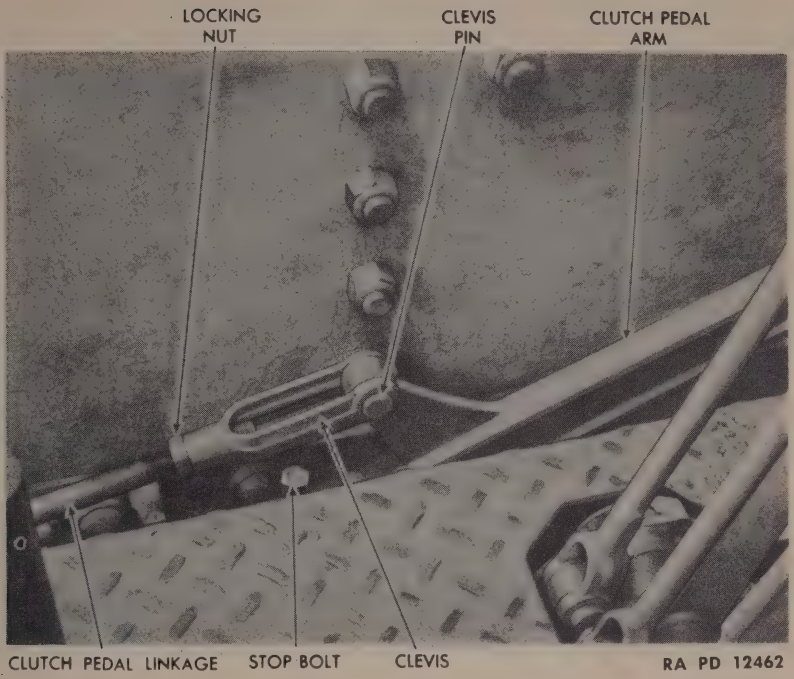


Figure 18—Detail of Clutch Linkage Adjustment

earliest opportunity, at which time the emergency stop should be reset to its original position. Before starting the engine, the driver makes inspections in the driving compartment covered in steps (8) and (9).

(8) CHECKING THE INSTRUMENT PANEL (fig. 11).

(a) Inspect the voltmeter (switch open) to see that the needle is against the stop.

(b) Close 12-volt battery switch (back switch). Close 24-volt battery switch (front switch) and check voltmeter for 24-volt reading and check ammeter for zero reading.

(c) Check fuel gage for adequate fuel supply.

(d) Check head light and siren operation, watching ammeter for indication of discharge.

(e) Check operation of solenoid fuel cut-off switch.

(9) OTHER DRIVER INSPECTIONS MADE BEFORE STARTING ENGINE.

(a) Check free travel in the clutch pedal and adjust if there is insufficient free travel, as indicated in step (7) of this paragraph.

(b) Check the accelerator pedal for free operation without binding.

(c) Check hand throttle operation for freedom of movement.

(d) Check gearshift lever operation, being sure that the latch is operating and the lever can be put into various positions.

(e) Check parking brake by releasing the lever and reengaging the brake.

(f) Pull back both steering levers to check proper adjustment (par. 105 b (8)).

(g) Depress floor drain valve and check proper operation.

(h) Secure report on engine oil level and transmission oil level.

(i) Other inspections are made during engine warm-up (par. 9).

(j) Check differential and transmission oil level.

(k) Check general condition of sprockets, bogies, springs, track supporting rollers, and idlers.

(l) Check track for wear, tightness, and tension.

(m) Check turret operation and locking mechanism.

(n) Check to see that all equipment is stowed properly.

8. ENGINE STARTING AND WARM-UP.

a. Easy starting, operating efficiency, and the effective life of the engine are greatly influenced by the care used by the driver in starting and warming up the engine. For that reason it is essential that the following procedure be followed, without variation, every time the engine is started, even though the tank is to be moved only a short distance.

b. **Procedure, Gasoline Engine** (fig. 19).

(1) Have engine turned over four complete crankshaft revolutions by hand (about 50 turns of the *hand crank*).

(2) Have fuel shut-off valves checked and turned on (4 in tank, 2 outside tank). (fig. 19)

(3) Turn on the booster switch and listen for the buzzing sound indicating proper booster operation.

(4) See that the gearshift lever is in neutral.

(5) Unless the engine is already warmed up, prime the engine by a few strokes of the priming pump (pull plunger out slowly, push in briskly). Avoid overpriming, which tends to wash the oil down off cylinder walls, causing serious damage.

(6) Open the hand throttle slightly.

(7) Depress the clutch pedal to completely disengage the clutch. This removes the load of the propeller shaft and transmission from the starting motor, for faster engine cranking.

(8) Close the starter and booster switches. (If necessary, continue to prime the engine while starting.) CAUTION: Never hold the starter switch closed for more than 30 seconds at a time. Then allow starter to cool off before attempting to turn the engine over again.

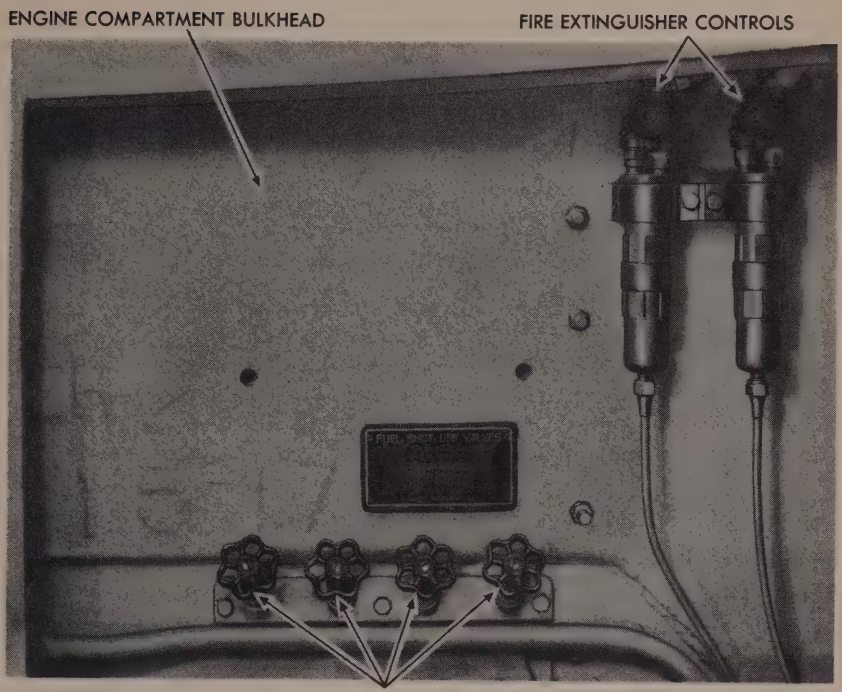


Figure 19—Location of Fuel Shut-off Valves

(9) Wait 2 seconds and then turn the magneto to the "BOTH" position. If the engine fails to start, repeat the process. If the engine has been overprimed and is flooded, turn it over with the starter, holding the accelerator wide open, *but with the magneto switch off.* After engine starts, press lightly on foot throttle. *Do not pump throttle.* Too much gas when the engine first starts will cause it to stall.

(10) As soon as the engine starts, *watch the oil pressure.* If it does not start building up pressure on the gage within 10 seconds, at 800 revolutions per minute, shut off the engine and report the condition to the tank commander.

(11) Warm the engine at *800 revolutions per minute for 5 minutes.* The oil pressure should be between 50 and 80 pounds which is normal for the speed.

(12) After 5 minute period, increase to 1,000 revolutions per minute. If the oil pressure drops off, go back to 800 revolutions per minute for more complete warm-up.

(13) Check operations of instruments while warming up and note results on tank commander's report. The ammeter reading immediately

after starting may be as high as 55 amperes, depending upon the condition of the battery, and will gradually drop as the battery becomes charged. The voltmeter, after starting, may be as high as 28½ volts.

(14) Increase engine speed to 1,800 revolutions per minute and try magneto switch in "L" and "R" positions. A 100 revolution-per-minute drop in engine speed is permissible at this speed. CAUTION: Do not run engine on one magneto for more than a 30-second interval. Otherwise, the inoperative plugs will become carbonized.

(15) PRECAUTIONS IN ENGINE OPERATION.

(a) Never idle below 800 revolutions per minute at any time, including military ceremonies. Continuous idling will appreciably shorten the useful life of the engine.

(b) Don't operate until obtaining a *10 degree rise in oil temperature.*

(c) Normal oil pressure is 50 to 80 pound at operating speeds.

(d) Never lug engine below 1,600 revolutions per minute.

(e) Maximum oil temperature is 190 degrees.

(f) Operate engine from 1,800 to 2,100 revolutions per minute in the M4 and M4A1 Tank. Minimum operating speeds for brief periods only, 1,500 to 1,600 revolutions per minute.

(g) Do not attempt to start the engine by towing or coasting the tank except in case of an extreme emergency, as this may cause serious damage to the engine and transmission. Then use the following precautions:

1. Prior to towing, the engine should be cranked by hand 4 revolutions (about 50 turns of the handcrank).

2. The towing vehicle should be placed in first (low) gear.

3. The vehicle to be towed should be placed in fifth (or high) gear.

4. The engine should be primed by several strokes of the primer pump if the engine is cold. If the engine is warm, priming may be unnecessary.

5. After the vehicle starts moving, the clutch should be engaged smoothly.

6. After the engine starts, the ignition switch should be turned to the position "BOTH" magnetos.

(h) Care must be taken not to allow dirt to collect on cylinders, or to permit any object to block the flow of air to, or from, the cylinders, as this may cause overheating and preignition.

c. Procedure, Diesel Engine.

(1) Let oil drain from inlet manifold by opening drain cock. Close drain cock.

(2) Use decompression lever to put engine on decompression.

(3) Turn engine through four complete crankshaft revolutions by hand.

(4) Put engine back on compression.

(5) Turn on fuel shut-off valves (4 in tank, 2 outside tank).

(6) See that gearshaft lever is in neutral.

(7) Insert the proper cartridge in the starter.

(8) Open the throttle.

(9) Depress the clutch pedal to reduce starting load.

(10) Close the starter contact switch.

(11) As soon as the engine starts, release the throttle control to allow the engine to operate at 800 revolutions per minute.

(12) Watch the oil pressure gage. Do not operate the engine more than 30 seconds if the pressure does not start to build up.

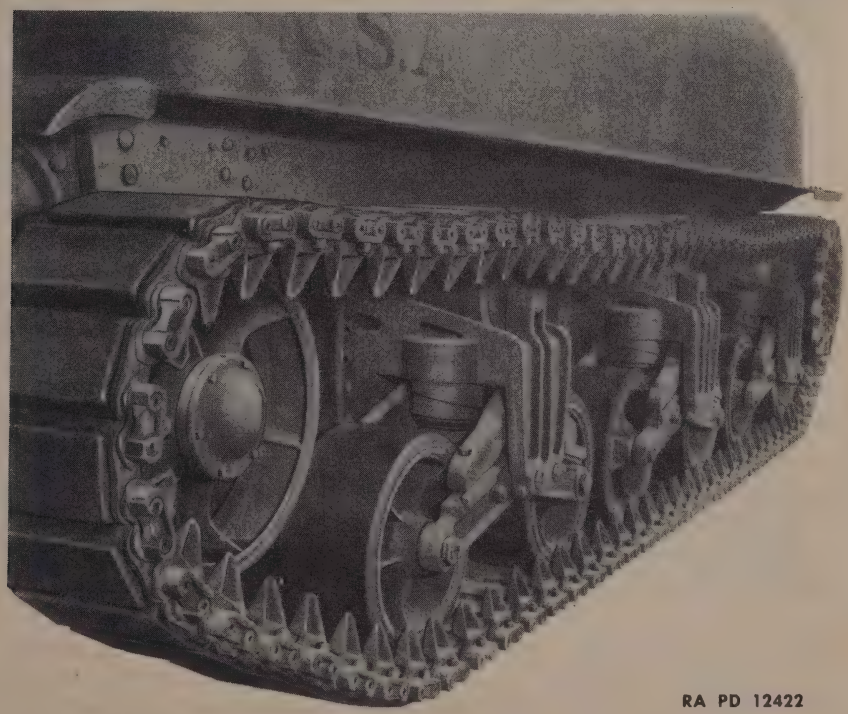
9. TANK INSPECTIONS DURING ENGINE WARM-UP.

a. The following inspections are to be made before and during the time required for engine warm-up.

b. Procedure.

(1) Inspect for oil leaks under the hull. This is done from both the front and rear of the tank and is one of the first inspections made or ordered by the tank commander. Trace possible cause of any leaks and correct condition.

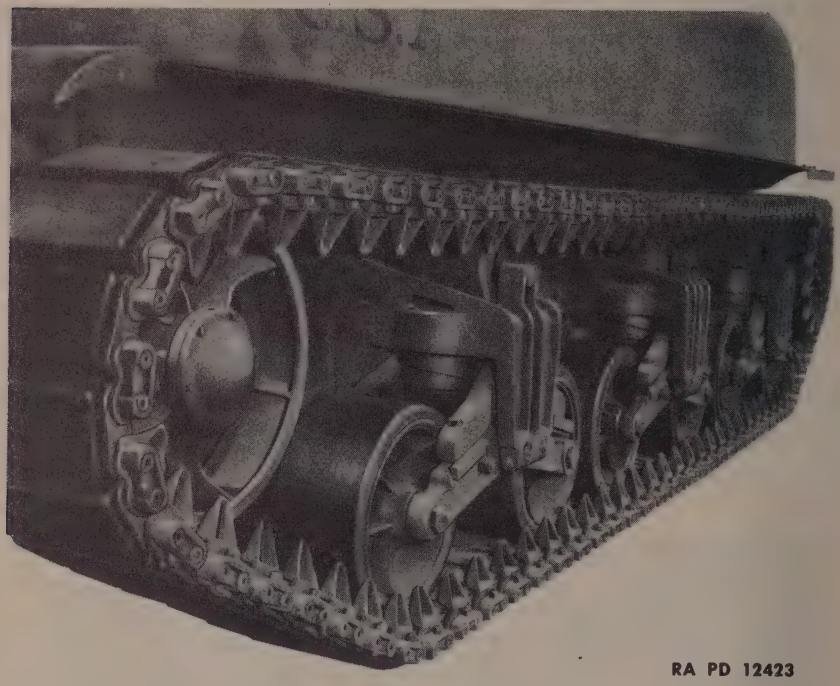
(2) INSPECT TRACK FOR TENSION (figs. 20 and 21). If the track



RA PD 12422

Figure 20—Example of a Loose Track

shows noticeable sag, the track should be tightened (sec. XXI, par. 112). NOTE: All instructions covering inspection and service of tracks apply equally to tracks with either steel or rubber blocks, with the exception that steel tracks cannot be reversed.



RA PD 12423

Figure 21—Example of Proper Track Tension

(3) INSPECT CONDITION OF TRACK. Check end connectors for wear, bent or broken guide lugs. Inspect all wedges and nuts for presence and tightness. Check presence of self-locking nuts. Check for bottomed wedges and replace. Clearance between wedge and connector should be not less than $\frac{1}{32}$ of an inch. If grousers are being used, inspect their condition and tightness. Inspect all slack portions of the track for the presence of dead track blocks and replace any such blocks (fig. 22). The presence of a dead track block is indicated by a block which has dropped definitely out of line. NOTE: To be detected, a dead track block must be on the top of the track. This necessitates moving the tank to make a complete inspection. At this time the inside wedges and connectors can also be inspected.

(4) INSPECT SPROCKETS. Check for sprung or worn teeth. Check cap screws and hub nuts for tightness. Check inside cap screws when tank is being moved.

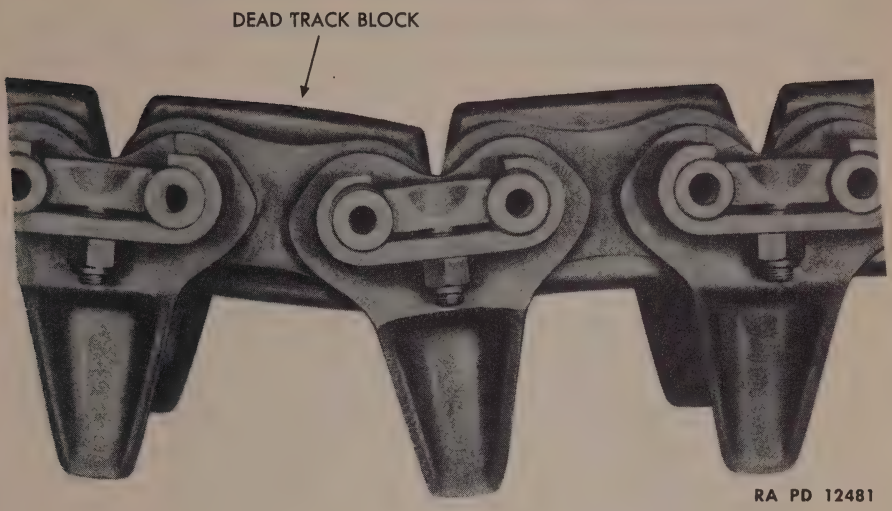


Figure 22—Dead Track Block Dropping Out of Line On Top of Track

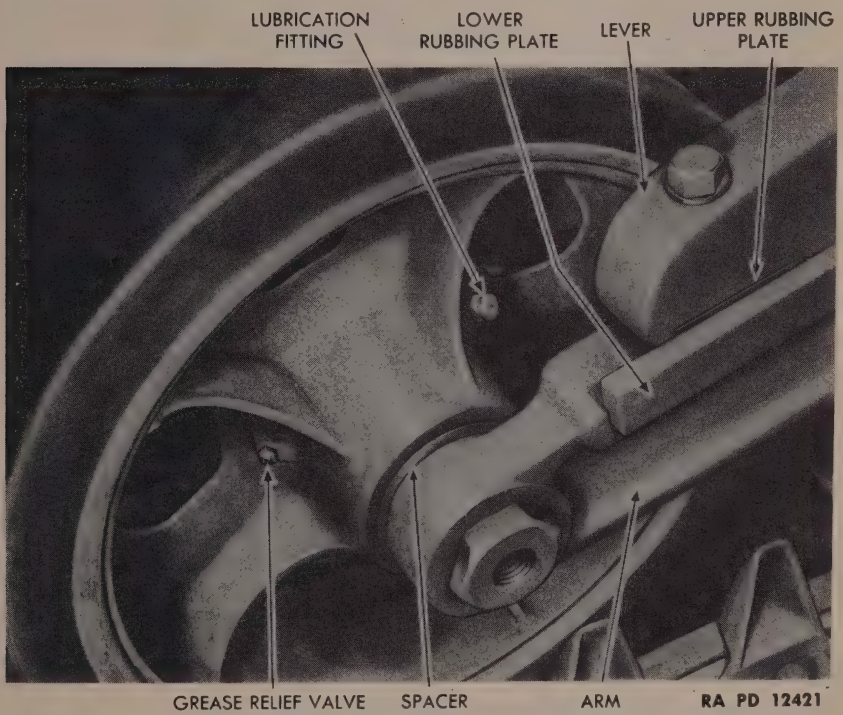


Figure 23—Detail of Bogie Wheel to Show Lubrication Fittings

(5) INSPECT BOGIE WHEELS (fig. 23). Check condition of tires on all wheels. Look for evidence of outer spacer turning and tighten gudgeon nut

if spacer is turning. Check gudgeon nuts for presence and see that cotter pins are properly installed. Check condition of grease fittings and release valves, and replace any that are damaged or missing.

(6) INSPECT BOGIE ASSEMBLIES. Check for broken or weak volute springs. Inspect wheel arm and lever wear plates for wear and replace if worn. Inspect bogie bracket for presence of bolts, nuts, and lock wire.

(7) INSPECT SUPPORT ROLLERS (fig. 24). Look for evidences of roller not turning and free up all rollers by cleaning out mud, rocks, etc. Check grease fittings and replace missing fittings. It is essential that all rollers turn freely, since inoperative rollers will develop flat spots.

(8) INSPECT IDLERS. Check for security of idler cap and grease fittings. CAUTION: It is highly important that the entire track and suspension system be kept as clean as possible and free from dirt, rocks, and sticks. This will protect the life and efficiency of the system (par. 39).

10. OPERATING THE TANK.

a. General Instructions. No attempt should be made by an untrained driver to operate the tank except with the personal help and supervision of a competent instructor. The operation of the tank requires definite techniques which can be learned correctly only by continued practice under trained direction. This applies particularly to the correct selection of gears for various terrains, and the knowledge of when and how to shift into lower gears in order to secure the maximum performance from both the tank and the engine. For that reason this paragraph is concerned not with detailed operating instructions which must vary with varying conditions, but rather with a number of basic operating precautions which should be observed by every tank driver.

b. Operating Instructions. With the driver in the driver's seat, the engine at idling speed, and all instruments showing normal readings, the driver is then ready to drive the vehicle.

(1) Release parking brake.

(2) Disengage clutch by pressing clutch pedal down to floor and holding it down.

(3) Move gearshift lever into second gear (fig. 10). First gear will be used only when moving vehicle in building or over obstacles.

(4) After speeding up engine, gradually release clutch pedal, at the same time depressing foot throttle. Except when under fire, attempting to move vehicle in or out of close quarters without aid of personnel outside of vehicle serving as a guide is very dangerous.

(5) Correct gear for running is that which enables the vehicle to proceed at the desired speed without causing the engine to labor. Do not ride clutch. The driver's left foot must be completely removed from clutch pedal while driving, to avoid unnecessary wear on clutch.

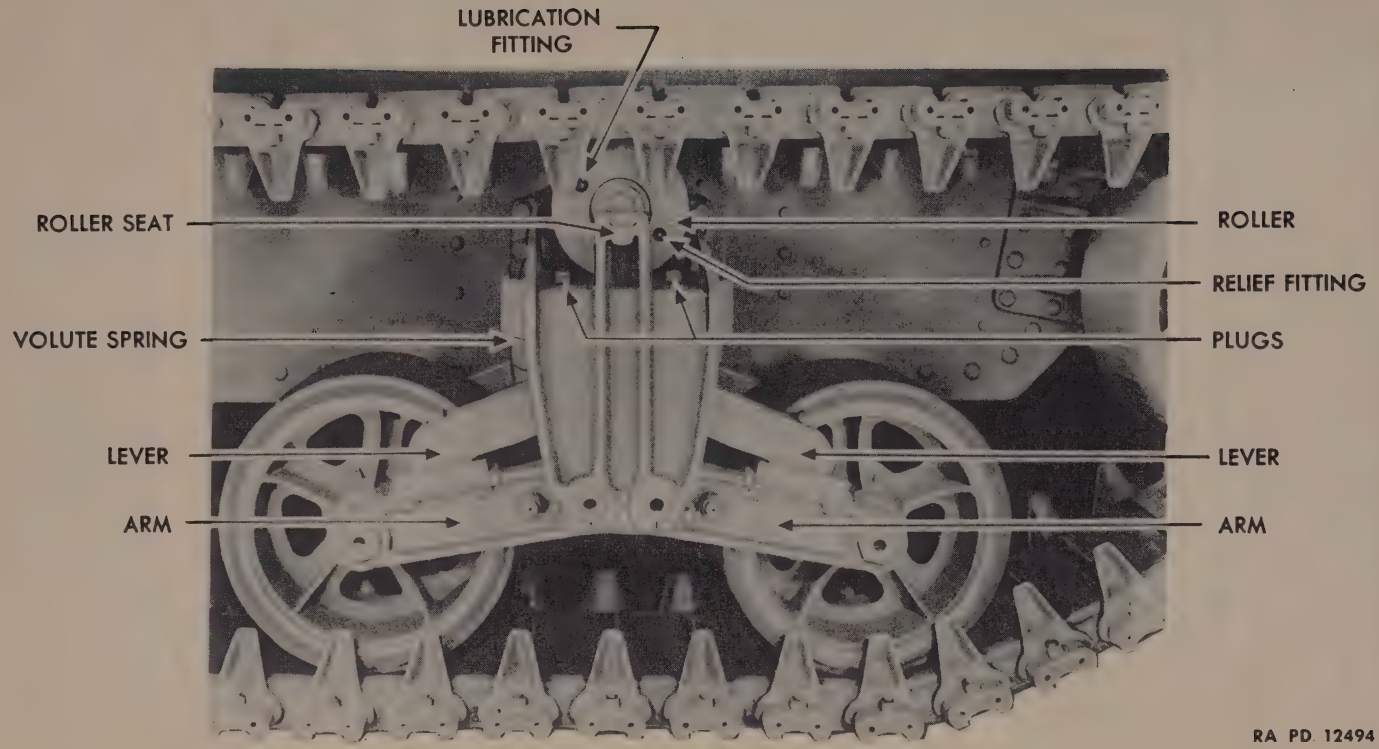


Figure 24—Suspension System On Medium Tank M4 and M4A1

(6) To place vehicle in reverse gear a complete stop must be made, and throttle closed to idling speed. Shift briefly into third gear to stop the propeller shaft. Then depress the latch and move gearshift lever to reverse position (fig. 10). Backing vehicle should never be attempted unless an observer is stationed in front to guide the driver.

(7) To steer, pull back the right-hand steering lever to make a right turn or the left-hand lever for a left turn. This action keeps one of the tracks from turning as fast as the other track and more power is needed. As the driver anticipates making a turn, he must be ready to apply the foot throttle to a greater extent, depending on the sharpness of the turn.

(8) To stop the vehicle, release throttle and pull back on both steering levers at the same time, depressing clutch when vehicle has slowed down to approximately 2 to 5 miles per hour, depending upon which gear is being employed before stopping.

(9) The parking brake is located on the back of the transmission to the right of the driver's seat. This brake should be used only for parking and never while the vehicle is in motion. The operator should always make sure that this brake is released before putting the vehicle in motion.

(10) Tachometer, oil temperature gage, and oil pressure gage give the most satisfactory indications of the engine's performance. Should indications of any of these instruments appear to be irregular, the engine should be stopped and cause investigated. Oil temperature should not exceed 190 degrees.

c. Precautions in Driving.

(1) Know the tank: its capabilities and limitations. Learn to judge the speed of the engine by the sound. Listen for unusual noises in the engine, transmission, as well as the rest of the power train.

(2) Keep engine speeds *up* to 1,800 to 2,100 revolutions per minute. Never lug the engine at wide open throttle below 1,600 revolutions per minute.

(3) Know approximate speeds in each gear and the corresponding revolutions per minute of the engine. This will aid in shifting and permit driver to keep tank under control at all times.

(4) Always keep power on tracks when turning. Shift down if necessary to keep engine speed up.

(5) Always select the correct gear before attempting hills, muddy areas, or long pulls.

(6) Do not turn when climbing a hill or just after shifting to a higher gear. Let the engine have every chance to regain speed before using the steering lever. Even a slight turn will drag down your speed.

(7) Use the engine as a brake when going down hills. Coasting with the clutch disengaged reduces the driver's control of the vehicle and can result in serious damage to both the clutch and power train.

(8) "Double-clutching" will aid when shifting down and, even on a synchromesh transmission, will make shifting quicker and lessen wear on cones in transmission.

(9) Let the steering levers go when not actually steering the tank or applying brakes. "Riding" the levers wears the brakes.

(10) Keep the left foot on the floor and off the clutch pedal, except when actually changing gears or stopping. Whenever the tank is moving, the clutch must be fully engaged.

(11) When moving the vehicle inside or around buildings, shops or confined spaces, use first or reverse gear. It is better to let the engine idle down and move slowly than to have engine speed too high and slip the clutch. Always have a trained guide outside the tank direct with hand signals when moving around in confined spaces.

(12) Learn how to cross obstacles correctly, keeping clutch engaged. In crossing ditches, let the tank settle gently and apply full power only when the tank has reached the bottom of the ditch.

(13) In breaking over an obstacle, let the tank rise and settle down over the obstacle, instead of applying full power in surmounting the obstacle.

(14) Except when necessary, never drive a tank that needs adjustments. It's safer to take a few minutes to correct these faults.

(15) Constantly watch the oil pressure gage (at least 50 lb at operating speeds), the tachometer and the oil temperature (maximum 190 deg).

(16) Never hold engine at wide open throttle (2,400 rpm) for more than a few seconds at a time. This is an emergency speed, not a driving speed.

(17) Always set parking brake after stopping tank. It is bad practice to leave tank in gear.

(18) Upon no occasion, including military ceremonies, will idling the engine at less than 800 revolutions per minute be permitted.

11. STOPPING THE ENGINE.

a. To Stop the R 975-EC2 and R 975-C1 Radial Engines.

(1) Idle the engine at 800 revolutions per minute 3 to 5 minutes and throw the fuel cut-off toggle switch to the "OFF" position which prevents fuel from leaving the carburetor.

(2) After the engine stops, turn off the 2 main fuel supply valves and open the main battery switch.

b. To Stop the "Guiberson" Diesel Engine.

(1) Idle the engine at 800 revolutions per minute 3 to 5 minutes and return the hand throttle to the "STOP" position.

(2) After the engine stops, open the battery switch.

c. After stopping the engine, the inspections of engine and tank (pars. 27 and 28) should always be made, and the trip ticket or tank commander's report filled out.

d. For use of the oil dilution system, refer to paragraph 12 c (1).

12. COLD WEATHER OPERATION.

a. Cold weather starting and operation, at temperatures of zero and below, require special precautions to assure starting and to avoid injury to engine and drive mechanism during warm-up and actual operation. Greatest dangers come from lubricating failures due to thickened oil, slow or blocked circulation of oil, and improper or too frequent use of the oil dilution valve.

b. Fuels.

(1) GASOLINE.

(a) Specifications. Use the winter grade of gasoline procured under U. S. Army Specification 2-103, latest issue, for the Continental Whirlwind Engine R 975-C1; use 91 octane motor or aviation fuel for the Wright Whirlwind R 975 EC-2, until it is converted to the R 975-C1 type.

(b) Formation of ice crystals from small amounts of water in the fuel sometimes causes trouble. Observing the following two precautions will help to keep water out of the fuel tank: Strain the gasoline through a chamois, being sure to keep the container and the fuel tank grounded. Insofar as possible, limit condensation of water in the fuel tank by keeping the tank full.

(2) DIESEL FUEL.

(a) Specifications. Diesel fuel, procured under U. S. Army Specification 2-102, latest revision, will be used at low temperatures.

(b) Formation of ice crystals from small amounts of water in the fuel sometimes causes trouble. Insofar as possible, limit condensation of water in the fuel tank by keeping the tank full.

(c) If emergency demands procurement of commercial fuel, extreme care will be taken to see that the cloud point is 10 degrees lower than the lowest atmospheric temperature anticipated.

c. Engine Lubricants.

(1) OIL DILUTION VALVE.

(a) To assist in engine starting and warm-up in cold weather, use the oil dilution system to thin the engine oil with gasoline.

(b) Since excessive oil dilution can cause serious injury to the engine, the operating instructions should be followed exactly. When low temperatures are anticipated, operate the oil dilution system just before stopping with the engine idling (fig. 45). Dilution in tanks equipped with a sole-

noid-operated, oil dilution valve is based upon time; in those with a visible oil dilution tank the device is used in cycles. In either case dilution will depend on an estimate of the lowest temperature anticipated at the next start. The engine must be shut off immediately after dilution. Dilution time *must not exceed* 3½ minutes or 4 cycles. The engine must be operated at least 30 minutes when started after a shut down on diluted oil; the valve *must not* be used, except during the dilution period.

(2) During the halt, or during overnight stops, close the engine compartment as tightly as possible, and cover the rear of the tank with a tarpaulin. If a shed or other shelter is available, it should always be used. Shutters can be used to cover the rear air exit of the engine compartment and need not be removed until the engine has begun to warm up. In extremely cold weather warm up the engine compartment by means of the auxiliary generator and heater. It is particularly important that the engine oil be warmed up before attempting to start the engine in sub-zero weather. Otherwise so little oil may be circulated that the engine may be seriously damaged during an attempted warm-up. If possible, remove the oil from the tank and keep in a warm place during overnight stops in extremely cold weather. If the oil is removed from the oil tank, mark the vehicle accordingly. This will reduce the possibility of starting the engine without oil in the oil tank.

(3) Oil pressure should be watched continuously during engine warm-up, and the engine stopped at once if any undue drop in pressure is noted, or if pressure fails to develop within 10 seconds.

d. Transmission, Differential and Final Drive Lubricants. For operation below 0 F use OIL, engine, SAE 30. After standing overnight at sub-zero temperatures, warm up the transmission as follows:

After the engine has been warmed up, engage the clutch and maintain an engine speed of 1,600 revolutions per minute for 2 minutes or until gears can be engaged. Put transmission in low (1st) gear and drive vehicle 100 yards, being careful not to stall engine.

e. Other Lubrication Points.

(1) Prior to continued exposure to sub-zero temperatures, remove bogie wheels and track roller bearings, wash them in SOLVENT, dry-cleaning, and reassemble. Lubricate with U. S. Army Specification 2-104, latest issue, or OIL, engine, SAE 30. If removal of bearings and washing in SOLVENT, dry-cleaning, is impractical, lubricate bearings, etc., by forcing in OIL, engine, SAE 30, immediately after vehicle has been driven and while the bearings are warm, forcing out the GREASE, general purpose used above 0 F.

(2) UNIVERSAL AND SLIP JOINTS. Lubricate with GREASE, O.D., No. 00.

(3) CLUTCH THROWOUT BEARINGS. Lubricate with GREASE, O.D., No. 00. Under conditions of 0 F. and below it may be necessary to service these bearings more frequently than for normal operation.

(4) All other places requiring GREASE, general purpose shall be lubricated with OIL, engine, SAE 30.

(5) CAUTION: When temperatures below 0 F. are no longer anticipated, the above bearings must be lubricated immediately with GREASE, general purpose, proper seasonal grade.

f. Refer to OFSB 6-11 for additional information.

Section III

ARMAMENT

	Paragraph
Description	13
Ammunition	14
Electric turret traversing mechanism	15
Hydraulic turret traversing mechanism	16
Operation of the stabilizer unit	17
Firing of the 75-mm gun and cal. .30 gun	18
Firing of other guns in the tank	19
Use of periscopes and telescopic sight	20
Operation of pistol port	21
Closing turret hatch	22

13. DESCRIPTION.

a. The armament installation in these medium tanks is as follows: A combination mount using a 75-mm gun and a cal. .30 machine gun in the turret; a flexible mount cal. .30 machine gun at the right bow of the tank; a cal. .50 or cal. .30 machine gun which can be mounted on the turret hatch ring for antiaircraft use; and provision for carrying a cal. .45 submachine gun in the turret.

b. The 75-mm gun and the cal. .30 machine gun (figs. 25 and 26) in the turret have a 360 degree traverse (secured by traversing the turret), an elevation of 25 degree, and a depression of 12 degree. These guns are provided with a stabilizer to hold them on the target when the tank is in motion. The gunner sits to the right of the 75-mm gun (fig. 26) and operates the elevation and traversing controls, the stabilizer controls, and the firing switches for both guns. The gunner sights through a periscope (par. 20) which has a telescopic sight built into the right side. The mount for the gunner's periscope (M3 or M4) is movable and is directly connected to the gun pivot by means of an arm and connecting link, so that its angle is automatically changed with any change in gun elevation.

c. The loader is stationed to the left of the 75-mm gun, which is loaded from that side. A periscope (par. 20) for the loader is located in the top of the turret. This is in a revolving mount and can be tilted to change the angle of vision. A pistol port is provided in the left side of the turret.

d. A bracket mount for a cal. .50 or a cal. .30 machine gun is provided on the revolving ring of the turret hatch ring. When the turret hatch doors are closed, a periscope in a revolving mount is provided for the tank commander. A latch locks the hatch cover in one position, when desired.

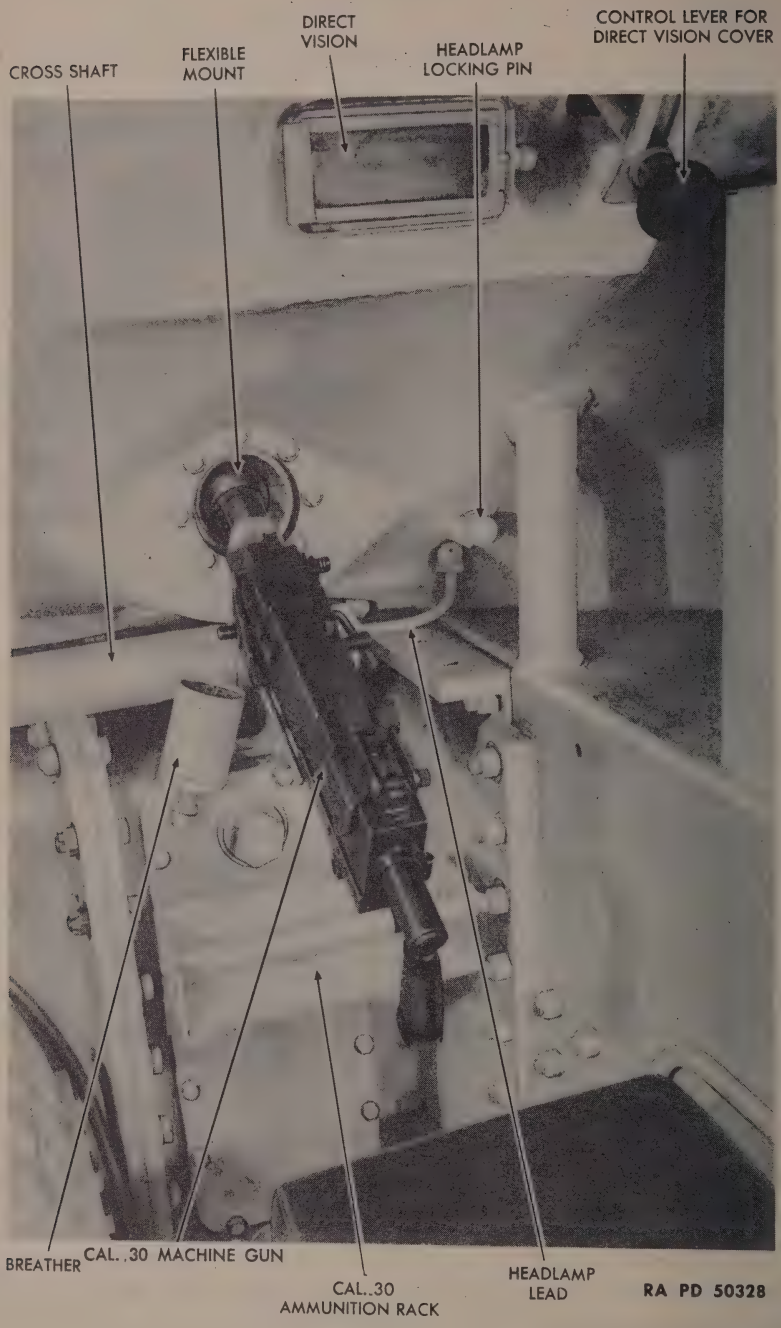


Figure 25—Assistant Driver's Station In Right Bow

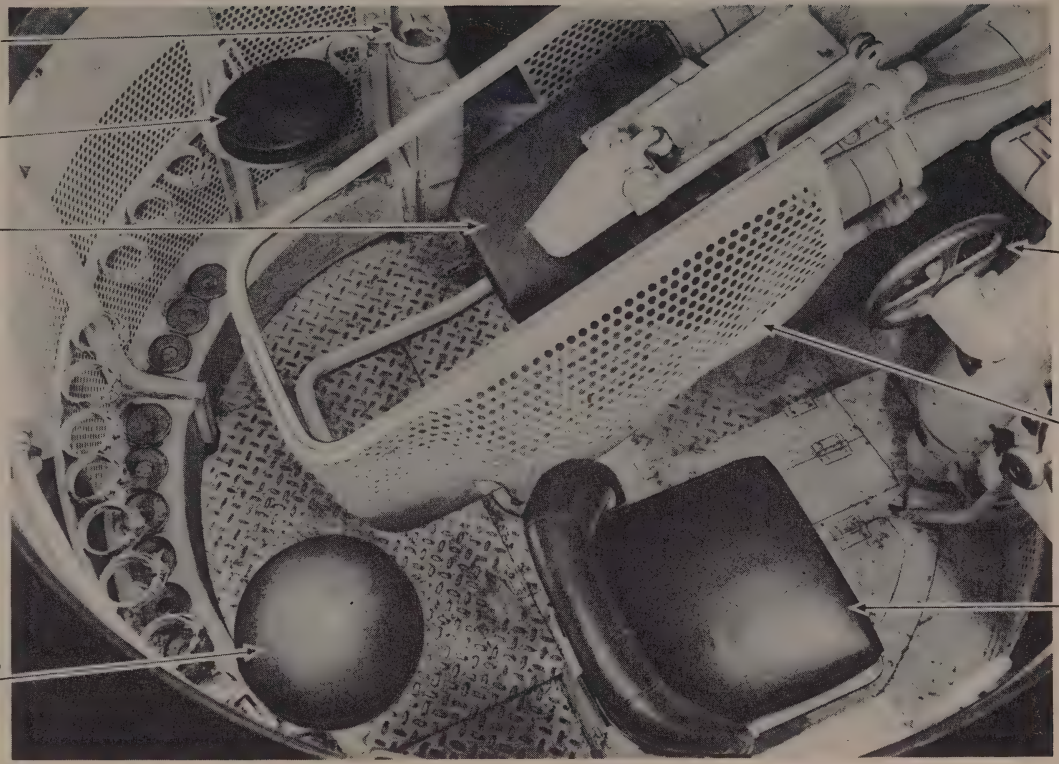


Figure 26—Interior of Turret to Show Stations

e. A clip for a cal. .45 submachine gun is mounted in the top rear of the turret, just above the radio. A cal. .30 machine gun is mounted in a flexible ball mount in the right bow and is manually operated by the assistant driver.

14. AMMUNITION.

a. Refer to section VIII, paragraph 40.

15. ELECTRIC TURRET TRAVERSING MECHANISM (figs. 27 and 28).

a. **Description.** The turret of some models of the Medium Tanks M4 and M4A1 can be traversed manually by means of a handwheel or mechanically by means of an electric motor. Power traversing of the turret may be done at varying speeds and in either direction, depending upon the direction and speed of rotation of the handwheel. For even faster traversing of the turret, such as would be necessary in changing quickly from one target to another, two special high-speed, two-way switches are provided, one for the gunner and the other for the tank commander. A safety switch keeps the power traversing mechanism inoperative as long as the handwheel is engaged for manual operation. 220-volt D.C. is supplied to the traversing motor by the turret motor generator set (fig. 27). The traversing motor, gear box, and traversing handwheel are located directly in front of the gunner (fig. 27). A handwheel at the gunner's right operates a locking clamp which, when engaged, prevents rotation of the turret. It is important that this locking clamp be completely disengaged (with the handwheel turned as far as possible to the *right* or *clockwise*) before power or manual traversing of the turret is attempted.

b. **Procedure for Traversing the Turret:**

(1) Close the hatches for the driver and assistant driver.

(2) Free the turret by turning the wheel of the turret clamp all the way to the *right* or *clockwise*. This disengages the teeth of the clamp from the teeth of the gear ring.

(3) Traverse the turret manually, by rotating the traversing handwheel to check to see that the turret is free. If the wheel turns freely and fails to move the turret, it has been pulled into the power traversing position and should be pushed forward into the manual position. To do this, it is necessary to depress the locking lever just ahead of the wheel and push the wheel forward, turning it slightly, if necessary, to engage it with the shaft. With the wheel in this position, the locking lever flange will seat in the inner groove in the handwheel shaft (fig. 28). Rotating the handwheel will now traverse the turret. The freeness of the turret must *always* be checked before using the power traversing mechanism.

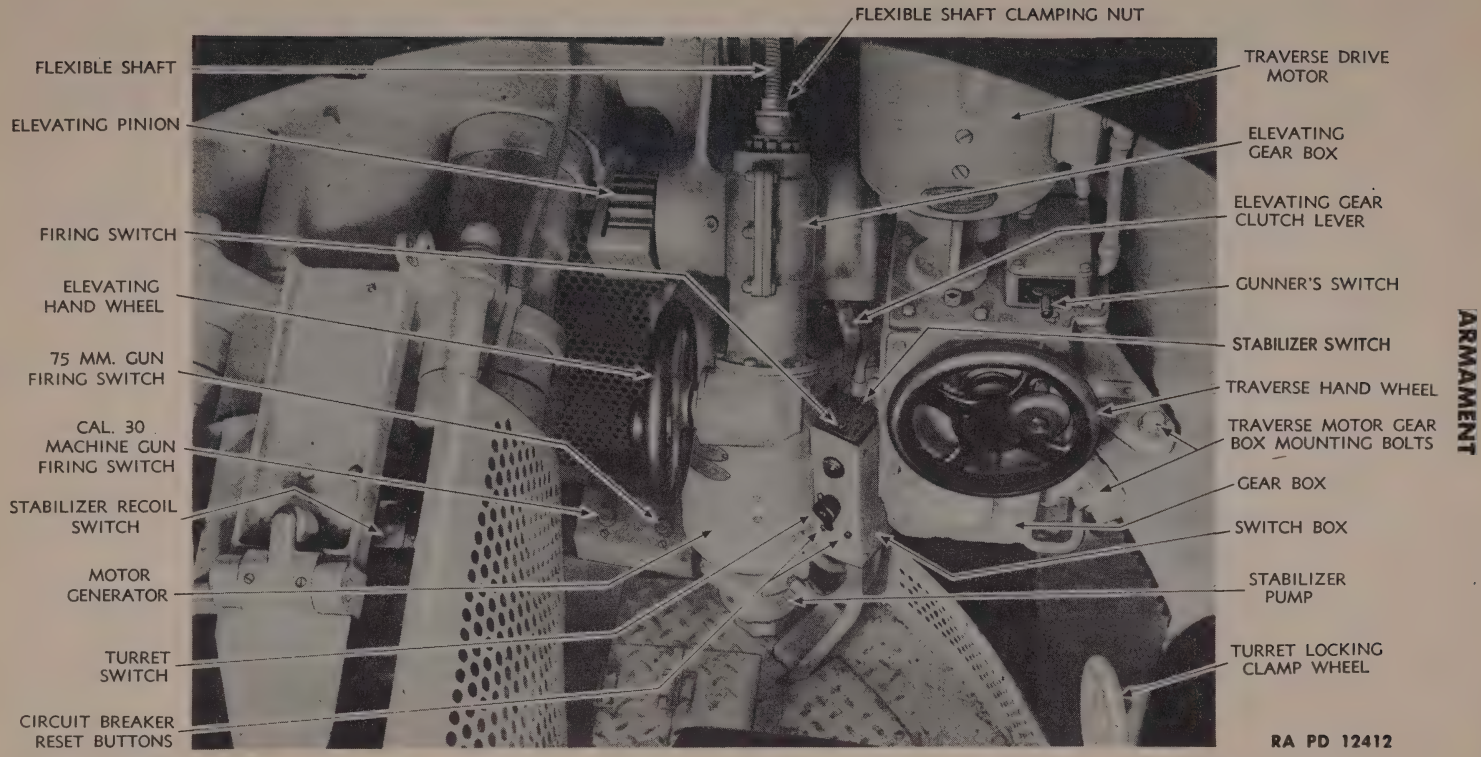


Figure 27—75-mm Gunner's Controls

Figure 28—Electric Traverse Gear Box Installed with Handwheel Removed

(4) If the power traversing mechanism is to be used, pull the traversing handwheel backward to the power position by releasing the locking lever. Then move the wheel backward until the flange in the locking lever seats in the outer groove on the handwheel shaft. (It may be necessary to rotate the wheel slightly to disengage the manual gear.)

(5) Turn the turret traversing motor switch on the electrical junction box to the middle or "ON" position (fig. 27). This turns on the turret motor generator set; if the traversing wheel and locking lever are in the power position and the safety switch is tripped (fig. 28), the traversing motor is also ready to operate.

(6) For tracking targets, the turret can now be rotated in the desired direction by the traversing handwheel (clockwise for right-hand rotation and counterclockwise for left-hand rotation). The traversing speed is in direct relation to the speed with which the handwheel is turned. Accordingly, the speed of the target will determine the speed at which the handwheel must be turned in order to lead the target.

(7) For changing rapidly from one target to another, either of the two-way, high-speed traversing switches may be used. The gunner's switch is located on top of the gear and control box, directly ahead of the handwheel. The tank commander's switch is located on the turret ceiling to the left front of the turret hatch. For high-speed turret traverse to the right, push the switch lever to the right. Pushing it to the left turns the turret in the opposite direction, or to the left.

(8) To return the traversing mechanism to manual operation, depress the locking lever and push the handwheel forward into manual position, seating the flange of the lever in the rear groove of the shaft.

(9) If the stabilizer is not to be used, turn the motor switch in either direction to the "OFF" position.

(10) Lock the turret by turning the turret clamp handwheel all the way to the left or counterclockwise, rotating the turret slightly, if necessary, to engage the clamp in the gears.

16. HYDRAULIC TURRET TRAVERSING MECHANISM.

a. Description of Power System. Some M4 and M4A1 Tanks are equipped with a hydraulically operated turret traversing mechanism. In this installation the turret is traversed by means of a gear mechanism operated by an oil-driven hydraulic motor. The system provides for a supply of oil under pressure which is fed to one side or the other of the hydraulic motor, the direction and rate of flow, and rotation, being determined by a manually operated control valve. The operation of the system can be best understood by studying the illustrations (figs. 29 and 30) in connection with this description. The high oil pressure needed to traverse the turret is supplied by the hydraulic pump, which is run by an

MEDIUM TANKS M4 AND M4A1

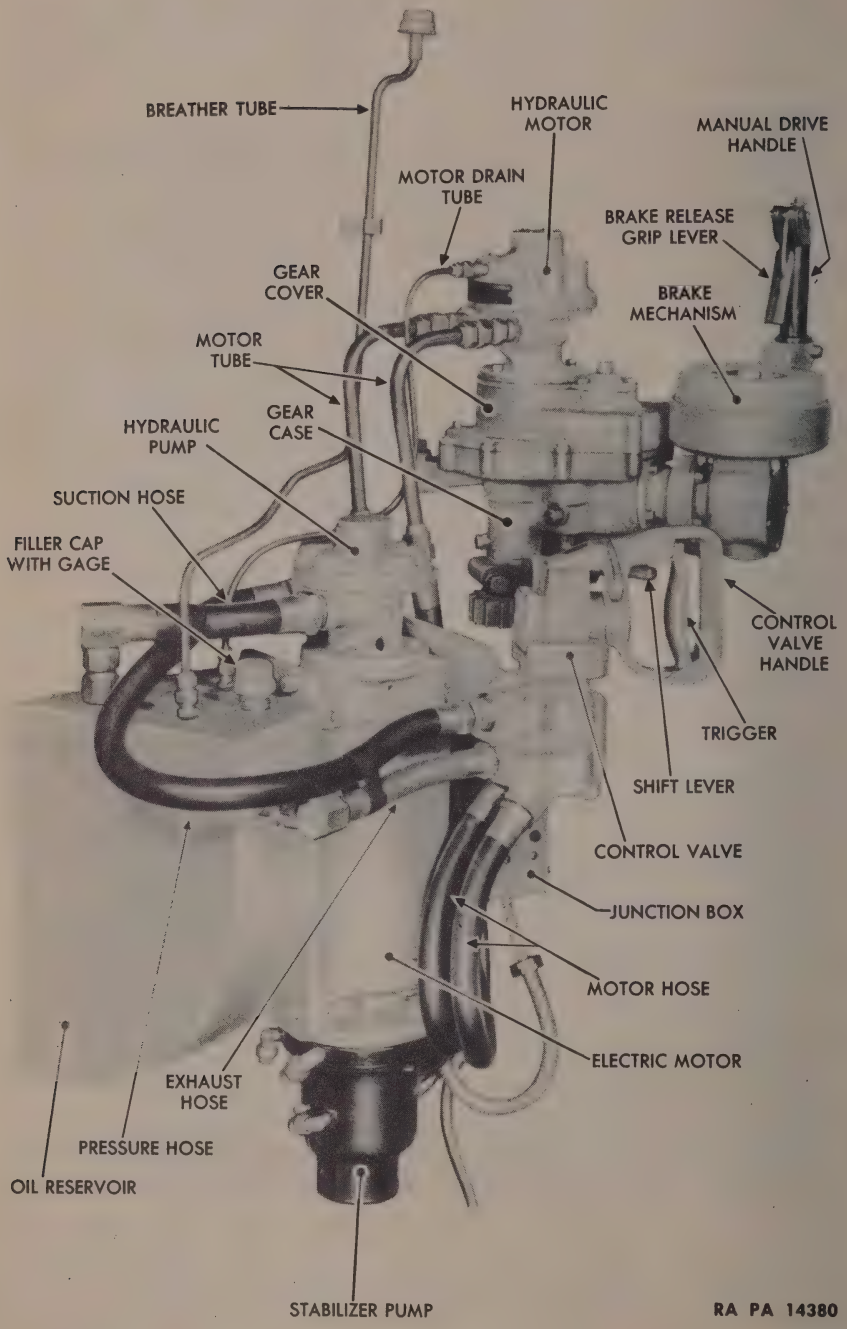


Figure 29—Hydraulic Turret Traversing Mechanism for Medium Tanks M4 and M4A1

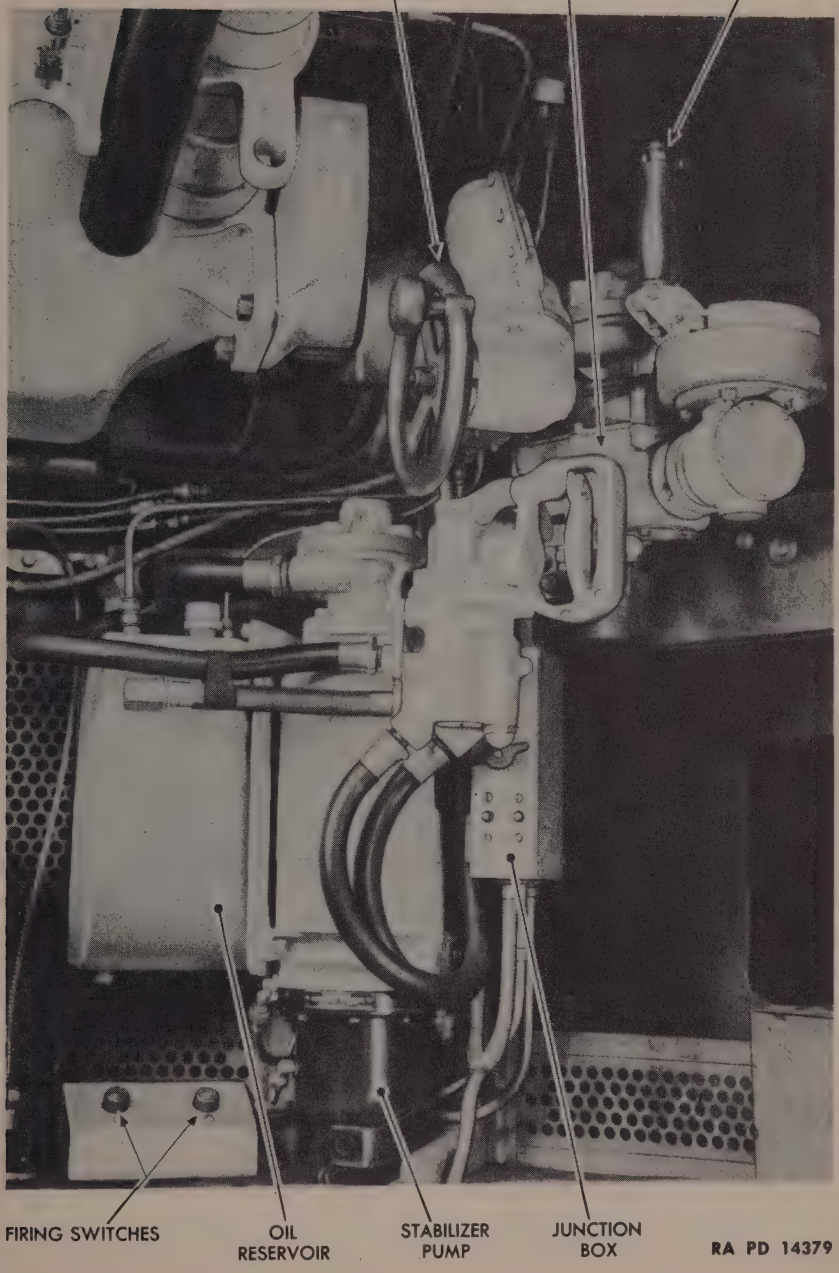


Figure 30—Hydraulic Turret Traversing Mechanism Installed in Tank

electric motor. The hydraulic pump pulls oil through the suction hose from the oil reservoir and forces it up through the pressure hose to the control valve. With the manually operated control valve handle in the neutral or vertical position, the oil will pass through the valve and back through the exhaust hose to the reservoir. With the control valve handle turned in either direction from vertical, some of the oil will be fed to one of the two motor hoses. The farther the handle is turned, the more oil goes through the hose, thus increasing the supply to the hydraulic motor. Oil coming into the hydraulic motor causes the motor to turn and to traverse the turret in the same direction in which the handle is turned. Turning the control valve handle in the other direction will feed oil under pressure to the other motor hose. This reverses the flow of oil through the hydraulic motor and thus changes its direction of rotation, and the direction of traverse of the turret. The control valve handle locks in the neutral or upright position when the trigger is not squeezed.

b. Description of Hand Traversing Mechanism (figs. 30 and 31). To enable the gunner to traverse the turret manually, in case it is not desired to put the hydraulic system into operation or in case of failure of the hydraulic system, a hand-traversing mechanism with a manual drive handle is attached to the right side of the gear case, and operates through the same gear mechanism used by the hydraulic motor. A shift lever at the bottom of the gear case disconnects the power traversing system and permits the hand-traversing mechanism to be used. When the shift lever is moved downward to the manual operating position, a brake mechanism prevents the turret from turning. The brake is released by means of a brake release grip lever mounted on the manual drive handle. With the release lever squeezed against the manual drive handle the turret can be rotated by turning the handle.

c. Operating Instructions (fig. 31).

(1) Check oil level in reservoir with bayonet oil level gage. Refill reservoir with OIL, hydraulic, if oil level is below full mark.

(2) Turn turret electric motor switch to the "ON" position. This will start the electric motor and the hydraulic pump.

(3) Check shift lever on gear box to be sure that it is raised to the power operating position.

(4) Grasp control valve handle firmly with left hand, squeezing trigger at the same time. The handle can now be turned in whichever direction it is desired to traverse the turret. The farther the handle is turned the faster the turret will be traversed. Turning the handle back to the vertical position will stop the turret from rotating.

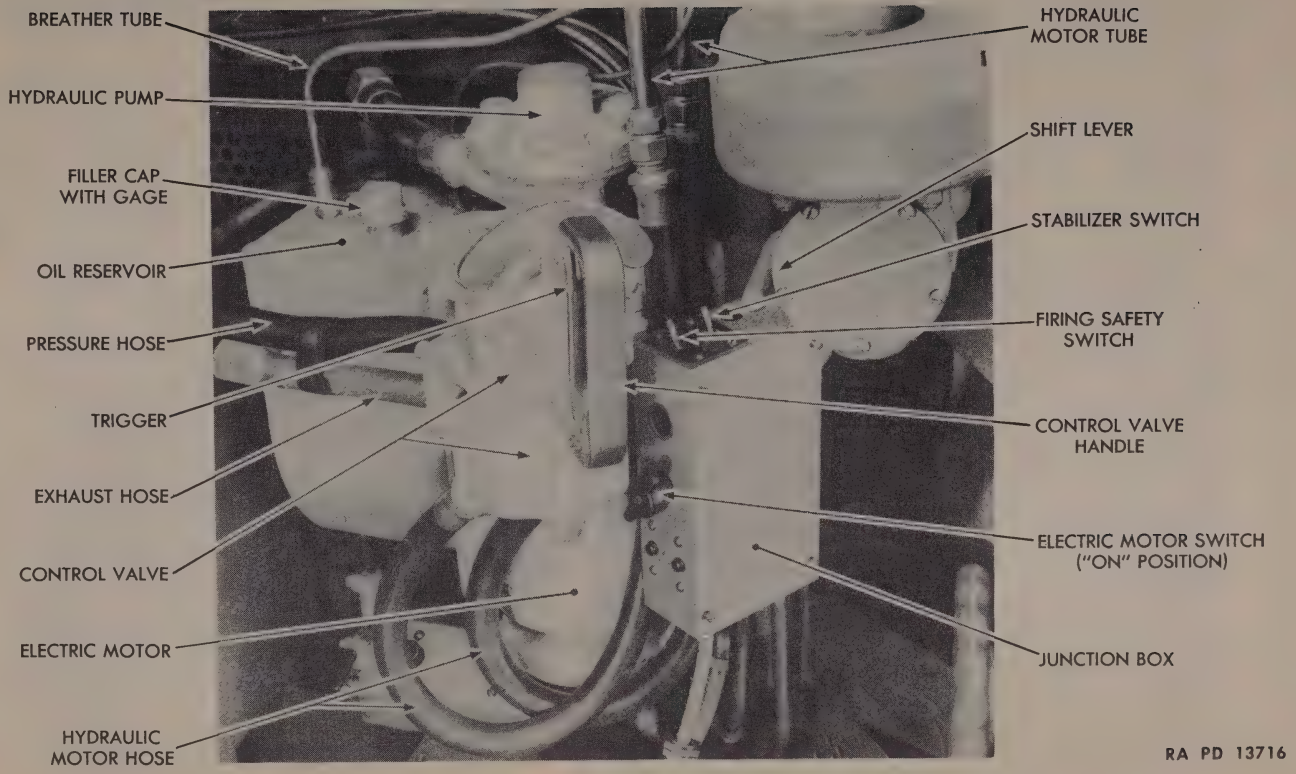


Figure 31—Controls of Hydraulic Turret Traversing Mechanism

(5) When turret traversing mechanism is not in use, lock the control handle in the upright position and turn off electric motor switch at junction box.

(6) To rotate turret manually, move shift lever on gear box downward to the manual operating position, grasp the manual traversing mechanism firmly with left hand, squeezing the brake release grip lever against the handle, and turn the handle in the direction in which the turret is to be moved.

17. OPERATION OF THE STABILIZER UNIT (figs. 32 and 33).

a. General. The stabilizer should be used only when the tank is in motion. To avoid drain on the tank batteries when the tank is standing still, the gun should be controlled with the hand elevating gears in mesh. This action automatically disconnects the stabilizer electrically by means of the disengaging switch.

(1) To get best results from the stabilizer the tank must be run at a constant speed. This may be done by selecting the proper gear and running the tank at the engine governed speed. Complete cooperation and understanding between driver and gunner are essential.

(2) When the stabilizer is in operation and the hand elevating gears

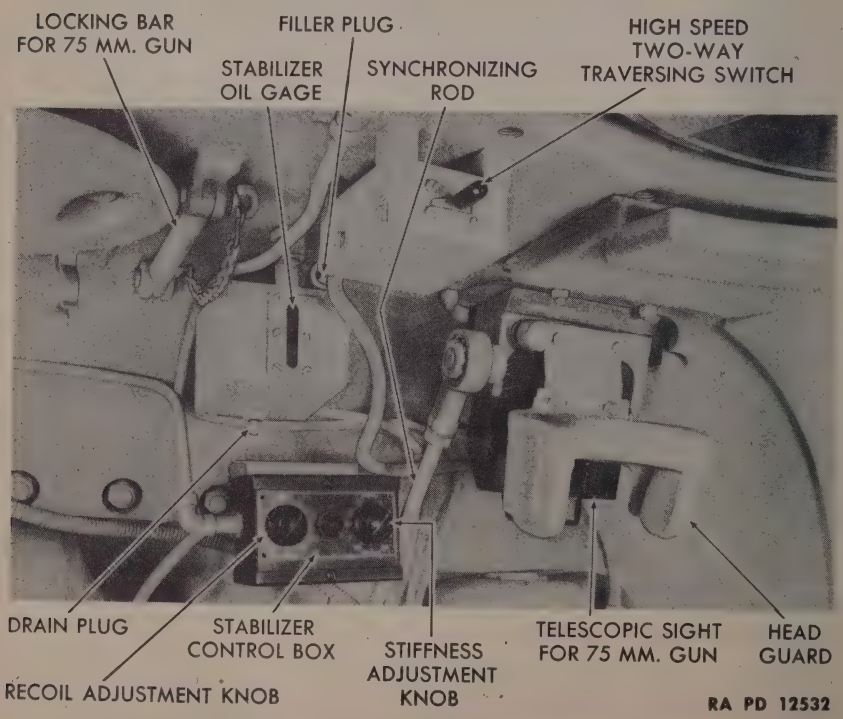


Figure 32—Upper Controls at Gunner's Station

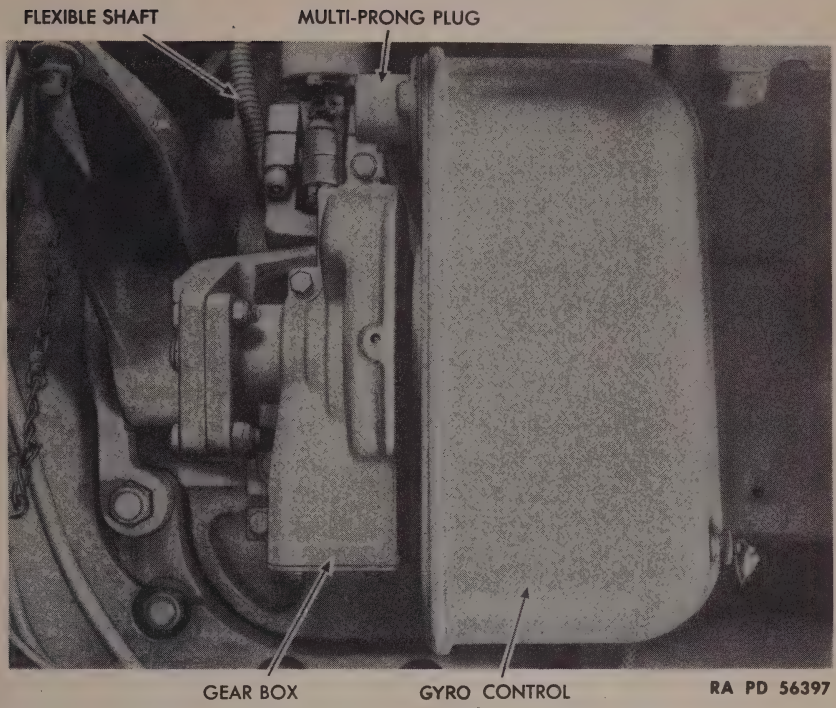


Figure 33—Gyro Control Unit Mounted Below 75-mm Gun

are out of mesh, the gun is elevated or depressed in the usual manner by turning the handwheel. This action changes the angular relation between the gun and the gyro control, and the gun automatically takes up the desired position as the gyro control immediately returns to its normal vertical position.

(3) When the tank is moving and oscillating or pitching normally and the stabilizer is operating normally, it will keep the gun very near its aimed angular position within its free range of angular movement, which is determined by its mounting in the tank. Therefore, after the gun is aimed, the stabilizer must be allowed to control the aimed position of the gun. The gunner turns the handwheel only when necessary to re-aim the gun when the target moves, the tank changes direction, or the elevation of the tank (other than that caused by normal pitching) changes. CAUTION: The handwheel should not be turned after the gun has reached its maximum limits of travel in the elevated or depressed plane. Continued turning of the handwheel with the gun against either stop will only displace the gyro control from its vertical position and cause an excessive overload on the oil pump and tank battery.

b. Starting the Equipment (fig. 32).

(1) Be sure the oil reservoir shows at least two-thirds full of OIL, hydraulic (Gov't Spec. 2-79-A).

(2) Set the stiffness rheostat at zero.

(3) Take the hand elevating gears out of mesh by sliding the knurled clutch release knob backward and moving the elevating clutch lever to the left (fig. 28). It may be necessary to bear down on the shoulder guard to remove tension from the elevating pinion before the clutch lever can be moved.

(4) Turn the handwheel until the gyro control is approximately vertical to avoid bumping tank occupants with the gun when the gyro control starts and turns vertical (figs. 27 and 33).

(5) Start the oil pump by turning the turret switch to the "ON" position.

(6) Start the gyro control motor by throwing toggle switch on top of turret switch box to the "ON" (left) position. Allow at least 1 minute for the gyro control to warm up.

(7) IMPORTANT: In cold weather the oil should be permitted to warm up to obtain the best performance. In sub-zero weather allow ½ minute running time for each degree of temperature below 0 F, for example, a total running time of 10 minutes to 20 degrees below zero.

c. Adjusting the Stiffness Rheostat. The stiffness rheostat, located in the control box (fig. 32), regulates the effectiveness or sensitivity of the stabilizer. Turn the control knob of the stiffness rheostat slowly to the right or clockwise. A vigorous vibration of the gun indicates too stiff an adjustment. Failure of the gun to remain in its aimed or set position indicates insufficient stiffness. If the gun starts to vibrate as the stiffness rheostat knob is adjusted, turn the knob in the opposite direction until the vibration is eliminated. It may be necessary for the operator to change the stiffness adjustment from time to time as operating conditions vary.

d. Adjusting the Recoil Rheostat.

(1) The recoil rheostat, located in the control box (fig. 32), provides an adjustment for maintaining the position of the gun during recoil. This adjustment must be made by trial and error while the gun is being fired.

(2) Set the recoil rheostat knob on No. 5 position.

(3) If the breech of the gun drops during recoil, turn the knob to the right or clockwise.

(4) If the breech rises, turn the knob to the left.

(5) If faulty operation is obtained from the stabilizer during recoil at all positions of the knob, check for looseness in the mounting and for correct adjustment of recoil switch.

e. Checking Stabilizer Operation. The stabilizer should be checked for effectiveness with the tank in motion before the tank is actually used in combat.

(1) Start the equipment.

(2) Choose a suitable location for a trial run of the tank. The terrain should be average rough, with no great slopes and sufficient acreage to permit adequate cruising time.

(3) Operate the tank over the average rough terrain at a normal speed. *Do not attempt to check the stabilizer operation while the tank is starting or stopping or making sharp turns.* The driver should be instructed to operate the tank in a straight line and at a constant speed.

(4) Aim the gun in the usual manner, using the horizon or some fixed object as the target.

(5) If necessary, adjust the stiffness rheostat.

(6) If possible, fire the gun and check the recoil adjustment.

18. FIRING OF THE 75-MM GUN AND CAL. .30 GUN (fig. 27).

a. These two guns are electrically fired by means of the two foot switches to the left of the gunner (fig. 27). These foot switches are in operation only when the toggle firing switch on the turret switch box is pushed to the left or "ON" position. The red signal light warns when the firing switch is "ON" and the foot switches ready to operate. The right switch fires the 75-mm gun and the left switch fires the cal. .30 machine gun. While the care and operation of the 75-mm gun is covered in TM 9-307, a few precautions in regard to the use of this armament in actual firing should be noted.

(1) Be sure the gun is bore-sighted and that the periscope is perfectly synchronized with the gun (par. 20 d).

(2) If the machine gun has not been accurately lined up, check it by firing on a target and make the proper adjustment at the rear of the gun mount.

(3) Before firing the 75-mm gun be sure the stiffness and recoil adjustments are properly set. The recoil should be set at 5 at the start and then adjusted if necessary.

(4) While firing from a moving tank, it will be impossible to hold the sight on the center of the target. With practice the gunner will be able to anticipate the movement of the gun and can fire just as the line of sight comes through the target.

(5) Driver and gunner should cooperate in securing effective hits. The driver should avoid making turns until after the gunner has fired. The gunner should compensate for the turning of the tank and lead the target by traversing the turret in the *opposite* direction while the tank is turning. This should be done by means of the handwheel which is always used in leading the target. The high-speed traverse switch

(electric traversing mechanism) is for rapid changing from one target to another and is more frequently used by the tank commander than by the gunner. It will turn the turret one complete revolution in 15 seconds.

19. FIRING OF OTHER GUNS IN THE TANK.

a. All other guns in the tank are fired by observation.

b. The assistant driver fires the cal. .30 machine gun by the conventional trigger and checks the fire by means of his periscope (par. 20).

c. The cal. .45 submachine gun can be fired through the pistol port at point blank range. Fire from this gun may also be observed through the periscopes (par. 20) of the loader or the tank commander. The cal. .45 gun can also be used to supplement the antiaircraft gun.

d. The antiaircraft gun is fired by the conventional trigger.

20. USE OF PERISCOPES AND TELESCOPIC SIGHT (figs. 34 and 35).

a. An indirect vision device called a periscope is provided for each crew member at his station (fig. 34). The mounting for each periscope,

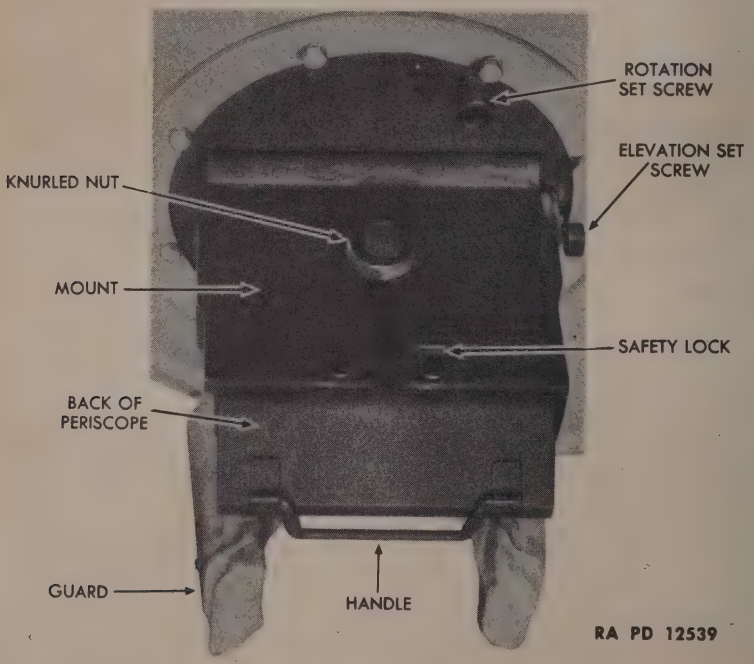


Figure 34—M5 Periscope Used in Medium Tank M4 and M4A1

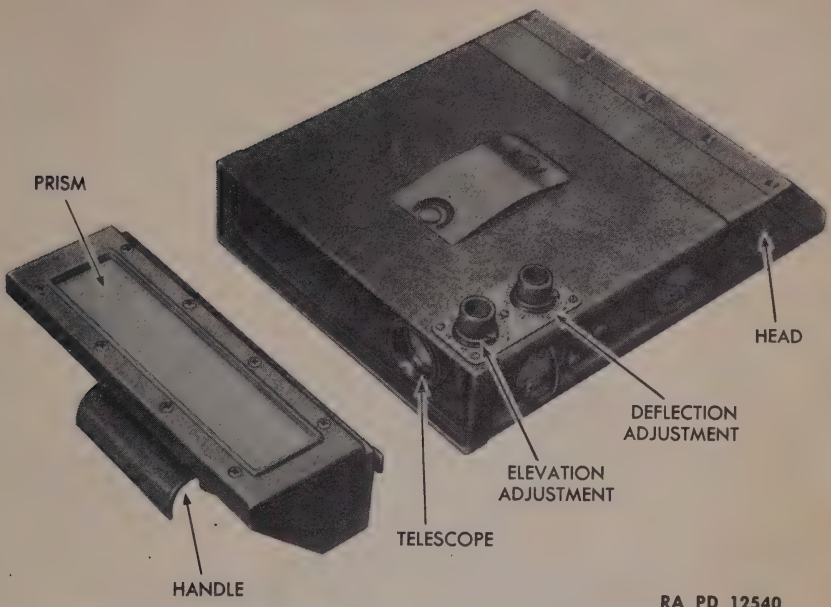


Figure 35—M4 Periscope for 75-mm Gunner

except that of the 75-mm gunner, includes a revolving plate which permits the periscope to be aimed in any direction. A rotation set screw can be tightened to hold the periscope in a fixed position if desired. The mount can also be tilted to change the elevation of the line of vision of the periscope. Another set screw is provided to hold the mount at a fixed elevation when desired. The periscope is held in place by means of a knurled retaining nut on the back of the periscope. A safety lock prevents the periscope from falling out if the nut becomes loosened.

b. To install the periscope, merely push it upward into place until the retaining bolt is against the mount. If the periscope does not enter freely, check to see whether the head guard bolts have been tightened down too far so that they protrude inside the periscope mount. Tighten the knurled nut at the back of the periscope and move the safety lock into place. To remove the periscope, unlatch the safety lock, loosen the retaining nut, and pull the periscope down by the handle.

c. The heads of the periscopes are replaceable and purposely made of relatively fragile materiel. Thus, in case of a hit, they will shatter rather than become wedged into the mount, making removal and replacement possible without delay due to jamming. The damaged head can be removed and a new head slid into place on the upper end of the periscope body. Care should be exercised in handling periscopes to prevent accidental cracking or breaking of the heads.

d. The mount of the 75-mm gunner's periscope is linked to the gun by means of an arm and rod linkage so that its position changes with any change in the position of the gun. This periscope includes a telescope which can be adjusted for elevation and deflection to provide perfect synchronization with the gun, as determined by bore sighting (fig. 35).

21. OPERATION OF PISTOL PORT (fig 36).

a. A pistol port is located on the left side of the turret, above the loader's seat, and is equipped with a heavy cover which can be locked open or closed down and securely latched. To open the pistol port, turn the rotating lever handle toward the right until the butt end of the lever faces the operator. This releases the latch that locks the port cover in place. Push down and forward on the lever handle and swing the port open. When the cover is out as far as it will go, turn the lever handle upward toward the left so that the lever locking pin slips into the notch at the left side of the opening. To close the port, push down on the lever handle and turn it to the right until the catch is released from the port notch. Drop the cover back into position and lock it by pushing the lever handle as far to the left as it will go.

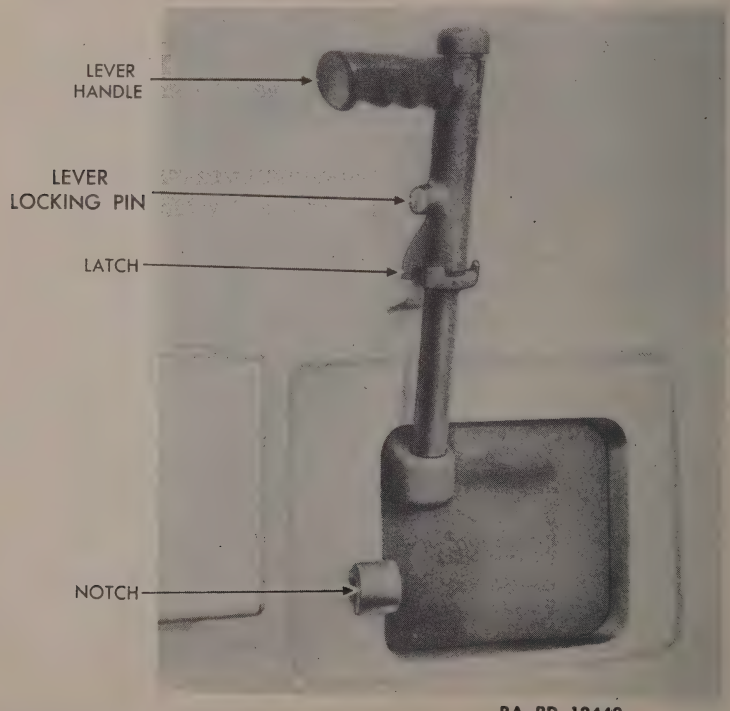


Figure 36—Pistol Port in M4 and M4A1 Turret

ARMAMENT

22. CLOSING THE TURRET HATCH (fig. 37).

a. When the turret hatch covers are open, a check release just below the hinge of each cover keeps them locked in the open position (fig. 37). To close the covers, pull out the release ring while pulling them closed. The cover without the locking levers should be closed first. Once both covers are closed, they should be locked by moving the latch handles to engage the latches with the rim of the hatch. To keep the hatch cover ring from revolving, turn it so the slot in the ring is in line with the latch, and move the latch into place.

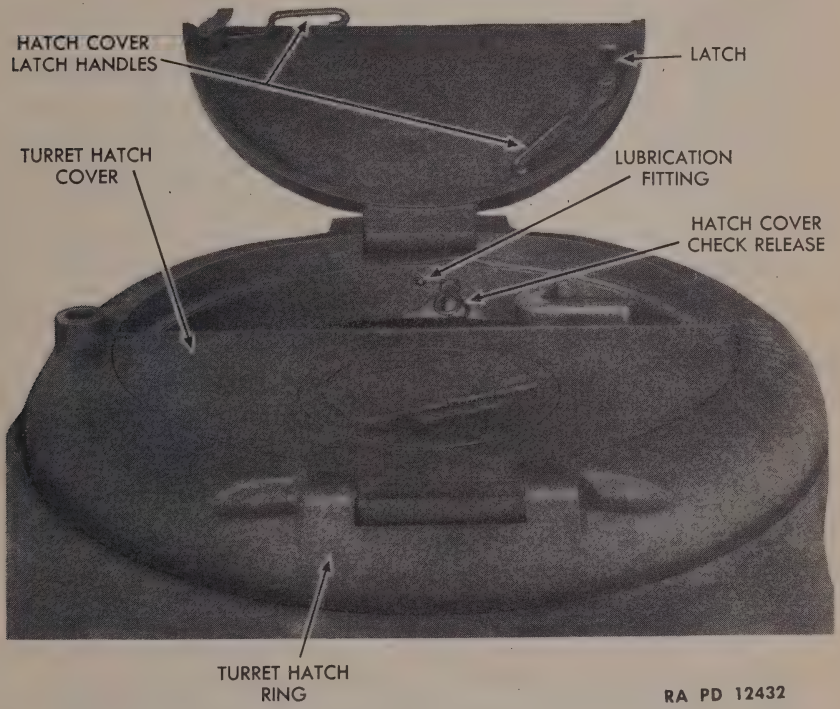


Figure 37—Detail of Turret Hatch

Section IV

AUXILIARY GENERATOR SET

	Paragraph
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23. DESCRIPTION (figs. 38 and 39).

a. The auxiliary generator is a self-contained unit designed for supplying 1,500 watts, 30 volts direct current power. It is used to charge the tank batteries at such times as the stabilizer unit, turret traversing motor, gun firing solenoids, radio, and its associated interphone installations draw current in excess of the output of the generator on the engine. The set is also designed to preheat the engine compartment in cold weather by means of an electric heater element, a blower, a heat duct, and the heat from the generator engine. The set consists essentially of an electrical generator provided with suitable controls and directly coupled to and driven by a 1-cylinder, air-cooled gasoline engine. A governor controls the speed of the engine at all loads. A control panel is mounted on the front of the unit. It carries control buttons for starting and for generator or heater operation. An ammeter is also included. The normal charging rate with a discharged battery is 50 amperes. With a fully charged battery, the ammeter reading should be from 3 to 5 amperes. The unit is located in the crew compartment, to the left rear of the turret basket. A separate fuel tank holds 5 gallons and is filled through a filler port in the hull just to the left rear of the turret (fig. 39). The engine averages 5 hours operation to a gallon of fuel.

24. OPERATION OF AUXILIARY GENERATOR SET.

a. **Fuel Mixture.** For proper lubrication of the unit, ⅜ of a pint of OIL, engine, SAE 30, must be thoroughly mixed with each gallon of gasoline, before the fuel is put into the tank. Thorough mixing is essential both to lubrication of the unit and to prevent "fouling" of the spark plug, intake and exhaust ports, and seriously affecting the efficiency and life of the engine.

b. **Starting.** In starting the auxiliary generator, use the following steps:

(1) COLD WEATHER OR COLD ENGINE STARTING (BELOW 50 F).

(a) Properly mix fuel and fill fuel tank.

(b) Open the shut-off cock on the fuel filter by turning the handle counterclockwise (fig. 38).

AUXILIARY GENERATOR SET

Figure 38—Auxiliary Generator Installed in Tank

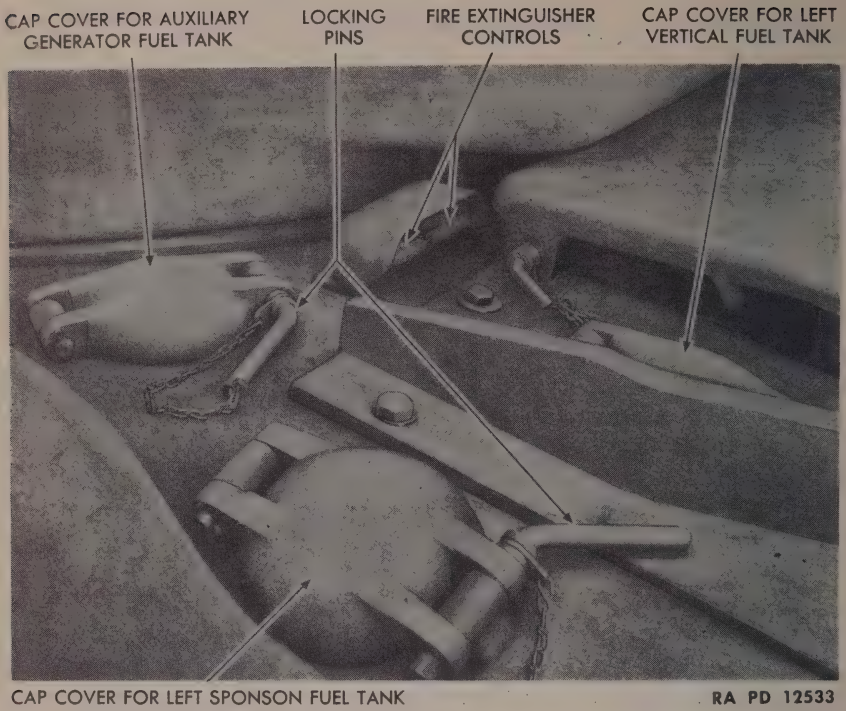
CAP COVER FOR AUXILIARY GENERATOR FUEL TANK
LOCKING PINS
FIRE EXTINGUISHER CONTROLS
CAP COVER FOR LEFT VERTICAL FUEL TANK
CAP COVER FOR LEFT SPONSON FUEL TANK
RA PD 12533

Figure 39—Fuel Tank Cap Covers on Left Side of Hull

(c) Close the carburetor choke. The choke is open when the lever is against the stop pin. The lever is located on top of the carburetor directly behind the engine.

(d) Depress the starting button on the control panel. Release the button as soon as the engine starts and immediately open the choke partially, easing it to the full open position as the engine warms up.

(2) Warm Weather or Warm Engine Starting (above 50 F).

(a) Same as in (1).

(b) Same as in (1).

(c) Depress the starting button on the control panel. Release the button as soon as the engine starts. NOTE: Do not use the choke unless the engine does not start within 5 seconds. If engine does not start, use choke as instructed in (1), *(c)* and *(d)*.

(3) Emergency manual starting (if the batteries are dead or if the generator is to be started for testing) is readily accomplished by prying open the three clips on the magneto shield, removing the front half of the shield, and winding the starting lanyard counterclockwise on the exposed

starting plate. Giving the rope a hard pull will spin the engine quickly. For manual starting, the choke should be closed. If the engine fails to start, rewind the lanyard and repeat the operation.

c. Battery Charging. Depressing the battery button on the control panel utilizes the output of the generator to charge the batteries. The unit should be in operation, with the battery switch *in* whenever using the stabilizer unit, power traversing the turret, operating the radio or its associated interphone system, or firing any of the solenoid-operated guns. The ammeter indicates the rate of charge going to the batteries.

d. Warming the Engine Compartment. With the unit in operation, depressing the heater button on the control panel utilizes the full output of the generator to operate the heating element in the forward end of the air duct. Warm air is thus forced into the engine compartment through a hole in the bulkhead. The heat from the generator engine is also directed into the engine compartment.

e. Stopping the Generator Engine. To stop the engine, press the red stop button on the back of the magneto and hold it firmly until the engine stops. Then turn the fuel shot-off cock clockwise until fully closed.

MEDIUM TANKS M4 AND M4A1

Section V

PREVENTIVE MAINTENANCE

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Prestarting inspection 26
Inspections at the halt 27
Inspections at the end of operation 28
Periodic inspections 29

25. IMPORTANCE OF INSPECTIONS.

a. The effectiveness of the tank as a combat unit, and the safety of the crew depend upon the performance of the tank under any condition which may arise. The ability of the tank to negotiate difficult terrain, overcome obstacles, and extricate itself from critical situations is exceptionally high *if every part is in the best possible condition.* The maintenance of such fighting effectiveness in the field is largely a matter of continuous and thoroughgoing inspections of every part of the vehicle. These inspections are the responsibility not only of the tank commander but also of the entire crew. While definite inspection routines will be assigned to specific members of the crew, every man should be on the alert before operation, during operation, and at the end of operation, to notice, report and correct if properly authorized any condition which in any way might cut down the efficiency or operating life of the tank.

26. PRESTARTING INSPECTION.

a. A complete inspection of the tank will be made at all times before starting the engine or moving the tank. The specific items in this prestarting inspection are included in the trip ticket first echelon report or the tank commander's report. For reference, a copy of a typical first echelon report is given in paragraph 28 of this section. The procedure followed in the various steps of the inspections, before and during engine warm-up, has already been covered in section II, paragraphs 7, 8, and 9.

27. INSPECTIONS AT THE HALT.

a. Inspections will always be made at every halt. The length of the halt will determine the extent to which the following procedure can be followed, but as much of it as possible should be covered whenever the tank is stopped.

b. **Procedure.**

(1) Inspect track and suspension. Remove mud, dirt, sticks, and stones from wheel arms and from beneath support rollers. Make normal check for track adjustment, wedges and nuts, springs, idler serrations, etc.

(2) Check pioneer tools, towing clevises and equipment on hull for security.

(3) Inspect gun barrels. Tighten down machine gun barrels. See that all muzzles are properly covered.

(4) Inspect all vision devices and periscopes. Wipe glass with a clean, dry cloth. Replace any broken glasses.

(5) Check lights and siren for security. Wipe lenses of driving lights, if using, and of taillights with a dry cloth.

(6) Inspect fenders. Pry up if bent down. Tighten if loose.

(7) Look for oil leaks under engine, differential, final drive. Feel for excess heat at differential and final drives.

(8) Check idlers, bogies, support rollers for excess heat at hubs. Make note of any defect so it can be corrected at end of run.

(9) Inspect gas tank caps. Tighten if loose. Open venthole if clogged.

(10) At 10 Minute Halts and Longer.

(a) Open engine doors and check for: fuel or oil leaks, tight connections, security of engine accessories, and security of accessories in compartment.

(b) Correct any defects noted inside the tank during the run since the last halt, such as: clutch adjustment, steering adjustment, and leaks inside fighting compartment.

(c) Police brass fired during run.

(11) During operation, continuous inspections are made by the crew.

(a) Coolers are inspected to be sure they are free from obstruction so air can reach them.

(b) Ammunition checked to be sure it is properly stowed and secure.

(c) All instruments watched to be sure they are functioning properly.

28. INSPECTIONS AT THE END OF OPERATION.

a. At the end of the day's operation the tank should be thoroughly checked by the entire crew to uncover any damage, defects, or unsatisfactory conditions which may have developed during the operation. These should be determined at once, so that they can be corrected before the start of the next operation. The inspections should cover all items noted in the trip ticket or tank commander's report, except those relating to engine starting and performance. However, if the driver has observed any irregular or unsatisfactory performance of the engine during the operation, he will make necessary checks and adjustments at this time, and report any work that will be required of company maintenance. The completeness of the inspection at the end of operation is of vital importance in the preparation of the tank for the next operation. In addition, the more thoroughly the inspection is performed, the shorter will be the time required for the prestarting inspection at the start of the next

operation, and the more certain it will be that the tank will go into operation in the best possible combat condition.

b. First Echelon Report (Mechanical Inspection).

1. Engine oil level
*2. Transmission oil level
3. Fuel filter
†4. Fan belt
†5. Radiator coolant
6. Air cleaner
7. Fuel supply
8. Fire extinguisher
**9. Voltmeter
10. Engine (starting)
11. Starter
*12. Primer
†13. Choke
14. Oil pressure gage
15. Engine (idling)
16. Hand throttle
**17. Tachometer
18. Engine (acceleration)
19. Foot throttle
20. Ammeter
†21. Rear view mirror
22. Horn and siren
†23. Windshield wiper
24. Appearance
25. Steering
26. Lights
†Spot ( ) Dash ( ) Head ( )
†Dim ( ) Tail ( ) Stop ( )
Tactical ( )
27. Leaks
Engine oil ( )
Transmission ( )
Differential or final drive ( ) †Water ( )
†28. Tires (condition)
†29. Tires (pressure) including spare
30. Parts missing
31. Pioneer tools secure
32. Tarpaulin lashed down
33. Damage, body ( ) fender ( )
34. Tow cable
**35. Tracks
**36. Bogie wheels
**37. Vertical links
*38. Clevises
39. Heat indicator
*40. Turret mechanism
**41. Gun brackets
*42. Ports
43. Clutch
†44. Foot brake
45. Hand brake
46. Speedometer
47. Odometer
48. Engine (cruising)
49. Engine (speed)
50. Engine (power)

Remarks: .....

Driver ..... Car Comd'r .....
Clerk ..... Maint. Sgt. .....

NOTE: Check items listed daily. X indicates unsatisfactory. Explain unsatisfactory items under "Remarks."

File by vehicle for six months.

---

* Applies to tanks only.
** Applies to half-tracks and tanks.
† Not on M4 or M4A1 tank.

PREVENTIVE MAINTENANCE

c. **Daily Report (Trip Ticket).**

MILEAGE TO DATE .....
U. S. A. No. ..... Date ..... 194 .
Organization .....
Dispatcher .....

. . . . . **TRIP NUMBER 1** . . . . . .
Report to .....
Mileage In ..... Hour of Return .....
Mileage Out ..... Hour of Departure .....
Hours Motor Cut .....
Miles Run ..... Hours Run .....
Nature of Run .....

. . . . . **TRIP NUMER 2** . . . . . .
Report to .....
Mileage In ..... Hour of Return .....
Mileage Out ..... Hour of Departure .....
Hours Motor Cut .....
Miles Run ..... Hours Run .....
Nature of Run .....

. . . . . **TRIP NUMBER 3** . . . . . .
Report to .....
Mileage In ..... Hour of Return .....
Mileage Out ..... Hour of Departure .....
Hours Motor Cut .....
Miles Run ..... Hours Run .....
Nature of Run .....

TOTAL MILES RUN ..... TOTAL HOURS RUN .....

Accidents .....
.....

FUELS AND LUBRICANTS ADDED: Gasoline ..... Gals.;
Engine Oil ..... Qt Gear Oil ..... Qt; Antifreeze ..... Qt
Released ..... (A. M.) (P. M.): ..... Signature

NOTE: Fill in complete information at end of day's operation.
Sign report and give it to the Maintenance Sergeant.

29. PERIODIC INSPECTIONS.

a. In addition to the continuous inspections by the tank crew, periodic inspections of the entire vehicle will be made by company maintenance. This includes the 50-hour inspection and the 100-hour inspection (sec. XIII).

Section VI

LUBRICATION

	Paragraph
Importance of regular and proper lubrication	30
General instructions	31
Lubrication guide	32
Points to be lubricated by ordnance maintenance personnel	33
Reports and records	34
Table of capacities with recommendations at temperatures shown	35
Engine lubrication system	36

30. IMPORTANCE OF REGULAR AND PROPER LUBRICATION (figs. 40, 41 and 42).

a. One of the easiest and surest ways of getting the utmost in performance and operating life from a tank is to see that every moving part is provided at all times with correct lubricants in the right quantity. When this is done, all parts of the tank operate with the least amount of effort, require less work by the engine or by the crew, and deliver far more operating hours without need of adjustment or replacement due to wear. A properly lubricated tank will travel faster, climb steeper grades more easily and have a greater cruising range than one whose lubrication has been faulty or neglected. The likelihood of failures or break downs will be greatly reduced. The operating life and efficient performance of individual parts and of the tank as a whole will be greatly prolonged. Lack of lubrication, on the other hand, may be more effective than any enemy action in putting the tank out of commission.

31. GENERAL INSTRUCTIONS.

a. The following lubrication instructions for Medium Tank M4 and M4A1 are published for the information and guidance of all concerned, and supersede all previous instructions.

b. **References.** Materiel must be lubricated in accordance with the latest instructions contained in technical manuals and/or ordnance field service bulletins. Reference is made to the general instruction section (OFSB 6-10) for additional lubrication information, and to the product guide section (OFSB 6-2) for latest approved lubricants.

32. LUBRICATION GUIDE.

a. Lubrication instructions for all points that can be serviced by the

using arms are shown in lubrication guides (figs. 40, 41, and 42) which specify the types of lubricants required and the intervals at which they are to be applied. Guides from which information is reproduced are 10- by 15-inch laminated charts which are part of the accessory equipment of each piece of materiel.

33. POINTS TO BE LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL.

a. Starter (Direct Electric). At least every six months, clean and repack all ball bearings with GREASE, special, high temperature.

b. Generator.

(1) Every six months, clean and repack ball bearings with GREASE, special, high temperature.

(2) Coat pole and exposed armature shaft surfaces with OIL, engine, SAE 30, to prevent rusting.

c. Clutch Hub and Pilot Bearings. Clean and repack bearings with GREASE, ball and roller bearing, when clutch is disassembled, or every six months.

d. Magneto.

(1) Remove bearings.

(2) Clean and repack with GREASE, special, high temperature.

(3) Apply GREASE, special, high temperature, to distributor gear.

(4) Lubricate felt wicks and pole pieces with OIL, engine, SAE 30.

e. Turret, Traversing Gear Housing. Disassemble, clean, and repack gears with GREASE, general purpose, No. 1, above +32 F, and No. 0, below +32 F.

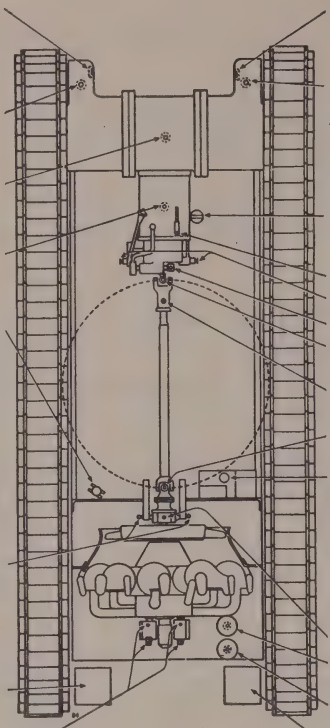
f. Throttle Control Cable. Lubricate cable conduit through fitting at ends of conduit with GREASE, general purpose, No. 1, above +32 F, and No. 0, below +32 F.

34. REPORTS AND RECORDS.

a. Reports. If lubrication instructions are closely followed, proper lubricants used, and satisfactory results are not obtained, a report will be made to the ordnance officer responsible for the maintenance of materiel.

b. Records. A complete record of lubrication servicing will be kept for the materiel.

ORDNANCE SERIAL NUMBER located on name plate inside fighting compartment.



Lubricant • Interval

Final drive (See Table) OE 3
(Fill and level plug) (Note 5)
(NOTE: See fig. 41 for other type construction)

Final drive drain plug
(Located under hull)

Differential drain plug
(Located under hull)

Transmission drain plug
(Located under hull)

Auxiliary generator
(Fill cap, bayonet gage)
(Note 9)

Interval • Lubricant

3 OE Final drive (See Table)
(Fill and level plug) (Note 5)
(NOTE: See fig. 41 for other type construction)

Final drive drain plug
(Located under hull)

SERVICED FROM FIGHTING COMPARTMENT

3 OE Trans. and diff. (See Table)
(Fill cap, level gage)
(Note 5)
1 CG Speedometer adapter (plug)
¼ CG Gear shift shaft
¼ OE Parking brake (oil hole)
1 CG Universal joint (fitting)
(Note 8)
1 CG Slip joint (plug)
(Note 8)
1 CG Universal joint (fitting)
(Note 8)
OE Engine oil tank (See Table)
(Fill cap, bayonet gage)
(Note 4)

SERVICED FROM ENGINE COMPARTMENT

Clutch throwout yoke brgs. CG ¼
(Also hand oil outer bearing OE D
race)
(Reached through ventilator
at top of tank)

Air cleaner OE
(Note 3)

Scintilla magnetos (SAE 10) OE 1

SERVICED FROM ENGINE COMPARTMENT

D OE Clutch sleeve (3 oil holes)
Fuel filter
(Note 7)
Oil filter
(Note 6)
OE Air cleaner
(Note 3)

NOTE—See figure 41 for lubrication of SUSPENSION SYSTEM and points reached from TURRET. For lubrication of TANK ARMAMENT, refer to Guide No. 58A and OFSB 6-A-45.

KEY

LUBRICANTS	INTERVALS
OE—OIL, engine Seasonal grade (unless otherwise specified) CG—GREASE, general purpose No. 1 (above +32°) No. 1 or No. 0 (+32° to +10°) No. 0 (below +10°)	D—DAILY ¼— 250 MILES 1—1,000 MILES 3—3,000 MILES **CHECK DAILY** Engine oil tank Air cleaners

RA PD 14346

Figure 40—Lubrication of Engine Compartment, Final Drive and Fighting Compartment Points

LUBRICATION

1. **FITTINGS.** — Clean before applying lubricant. Lubricate bogie wheels, idler and track support rollers until lubricant overflows relief valve. Lubricate other fittings until new grease is forced from the bearing. **CAUTION:** Lubricate suspension points after washing tank.

2. **INTERVALS.** — The intervals indicated at points on lubrication guide are for normal service. For extreme conditions of speed, heat, water, mud, snow, rough roads, dust, etc., change engine oil and reduce interval on guide by 1/2 or 1/3, or more if conditions warrant.

3. **AIR CLEANERS.** — Proper maintenance of air cleaners is essential to prolonged engine life. Drain, clean and refill with used crankcase oil or **OIL,** engine, seasonal grade, daily when operating on dirt roads or cross country; every 250 miles when operating on paved roads or during wet weather. Depending on operating conditions, remove air cleaner and wash all parts with **SOLVENT,** dry-cleaning every 100 to 500 miles. Inspect air outlet rubber hose connections for leaks and make sure pipes are in alinement. Replace connections if there is evidence of wear or deterioration. **CAUTION:** Keep all air pipe connections tight.

4. **ENGINE OIL TANK.** — Check oil level daily, add oil if necessary. Drain only when engine is hot. Drain every 500 miles or 50 hours when operating on dirt roads or cross country; every 1,000 miles when operating on paved roads or during wet weather. Clean tank and fill tube strainer every 1,000 miles. Refill oil tank to **FULL** mark on bayonet gage, located under fill cap. **CAUTION:** Do not remove strainer when filling tank. Keep crankcase breather cleaned and oiled.

5. **GEAR CASES.** — On some assemblies, the transmission, differential, and final drives are combined in one unit, filled through transmission filler only and drained through transmission and final drive drain plug holes. Other assemblies use three-piece units, filled through transmission filler and each final drive filler plug hole, and drained through transmission, differential and final drive drain plug holes. Check level daily, add oil if necessary. Check with tank on level ground. Drain, flush and refill at end of first 250 miles; thereafter as indicated at points on lubrication guide. When draining, drain immediately after operation. To flush cases, fill to proper level with oil, engine, **SAE 10.** Operate tank slowly in low gear for several minutes and redrain. Fill unit to level indicated. Clean transmission and differential filler strainer every 3,000 miles. **CAUTION:** Do not remove strainer when filling.

6. **OIL FILTER.** — Turn handle on top of filter one full turn daily. Remove drain plug every 250 miles to drain accumulated sediment.

7. **FUEL FILTER.** — Turn handle on top of filter one full turn daily. Every 250 miles, remove drain plug, located at bottom of filter, to drain accumulated water. Every 3,000 miles, wash elements and case in **SOLVENT,** dry-cleaning.

8. **UNIVERSAL JOINTS AND SLIP JOINT.** — Remove tunnel shield sections over universal joints and slip joint. Lubricate universal joints through fitting with **GREASE,** general purpose, seasonal grade, until grease overflows at relief valve. To lubricate slip joint, remove plug and insert fitting. Apply **GREASE,** general purpose, seasonal grade, until grease is forced from end of spline. **CAUTION:** After lubricating, remove fitting and replace plug.

9. **AUXILIARY GENERATOR.** — Two-cycled air cooled engine, mounted on left side driver's compartment behind turret basket, is lubricated by **OIL,** engine, mixed with the fuel. Mix thoroughly 3/8 pint **OIL,** engine **SAE 30,** with each gallon of gasoline before pouring into tank. **CAUTION:** Do not pour gasoline and oil separately into tank. Keep fuel strainer clean. Every 200 hours, lubricate magneto cam follower by oiling felt with one or two drops **OIL,** engine, **SAE 30.**

10. **HYDRAULIC OIL TANK.** — Located on floor of turret. Every 250 miles, check level by means of glass level gage or dipstick, whichever is provided. Add **OIL,** hydraulic, if necessary. Every 6 months, drain, flush and refill.

11. **OIL CAN POINTS.** — Every 250 miles, lubricate peep hole protector slides, hatch hinges and latches, door and shield hinges, seat hinges, traversing handcrank handle, pistol port covers, door latches, clutch shift bellcrank and clevises, steering lever bearings, foot pedal bearings, fuel tank cover lock pins and hinges, throttle linkage bellcranks and clevises, transmission shifter rail rods with **OIL,** engine, **SAE 30.**

12. **POINTS REQUIRING NO LUBRICATION.** — Bogie wheel suspension linkage and slides, final drive sprocket bearings, hydraulic pump and motor bearings.

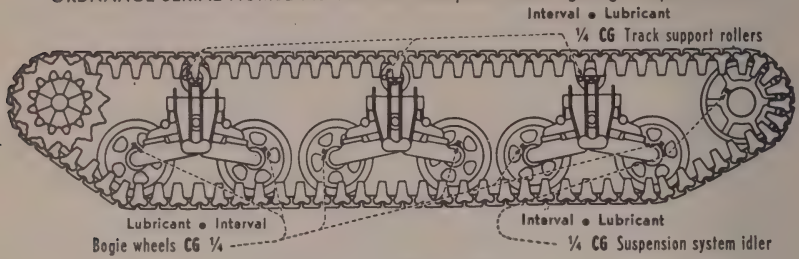
13. **POINTS TO BE LUBRICATED AT TIME OF ENGINE REMOVAL FOR PERIODIC INSPECTION.** — Clutch pilot bearing and clutch hub bearing.

14. **POINTS TO BE LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL.** — Clutch pilot bearing, clutch hub bearing, generator, magneto (except oilers), starter, throttle control cable, turret traversing gear housing.

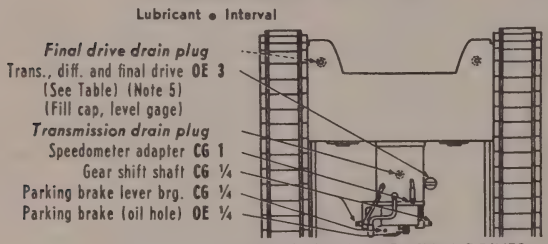
RA PD 14346B

Notes for Figures 40 and 41

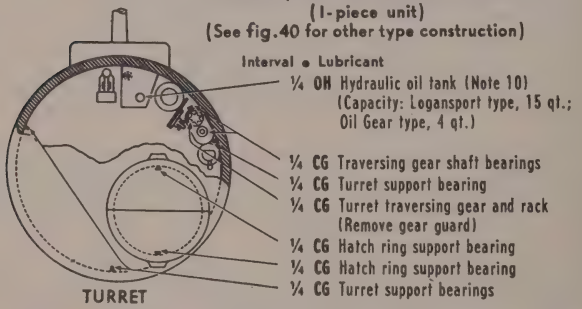
ORDNANCE SERIAL NUMBER located on name plate inside fighting compartment.



CAUTION—Lubricate Suspension System Points on BOTH SIDES of Tank.


Lubricant • Interval
Final drive drain plug
Trans., diff. and final drive OE 3
(See Table) (Note 5)
(Fill cap, level gage)
Transmission drain plug
Speedometer adapter CG 1
Gear shift shaft CG ¼
Parking brake lever brg. CG ¼
Parking brake (oil hole) OE ¼

TRANS., DIFF. AND FINAL DRIVES
(1-piece unit)
(See fig. 40 for other type construction)


Interval • Lubricant
¼ OH Hydraulic oil tank (Note 10)
(Capacity: Logansport type, 15 qt.;
Oil Gear type, 4 qt.)
¼ CG Traversing gear shaft bearings
¼ CG Turret support bearing
¼ CG Turret traversing gear and rack
(Remove gear guard)
¼ CG Hatch ring support bearing
¼ CG Hatch ring support bearing
¼ CG Turret support bearings

TURRET

NOTE—See figure 40 for lubrication of ENGINE COMPARTMENT, FINAL DRIVE and FIGHTING COMPARTMENT points. For lubrication of TANK ARMAMENT, refer to Guide No. 58A and OFSB 6-A-45.

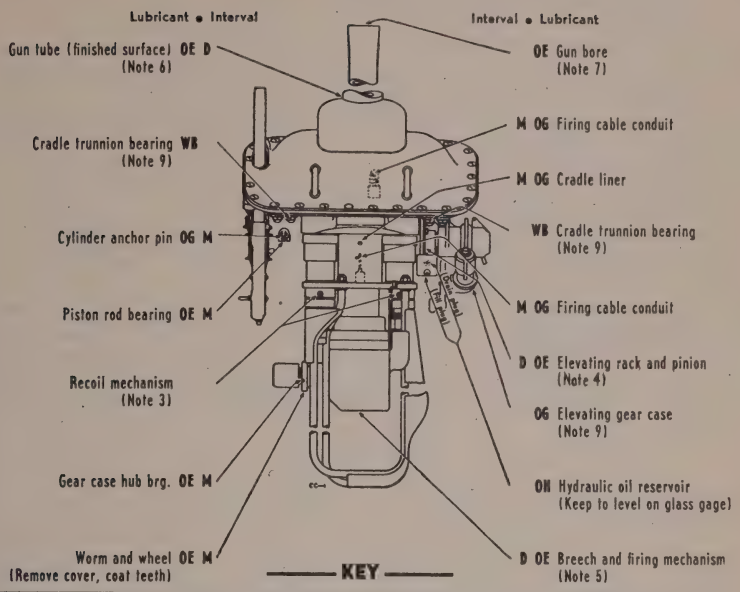
KEY

LUBRICANTS		INTERVALS
OE—OIL, engine Seasonal grade (unless otherwise specified)	CG—GREASE, general purpose No. 1 (above +32°) No. 1 or No. 0 (+32° to +10°) No. 0 (below +10°)	¼— 250 MILES
	OH—OIL, hydraulic	1—1,000 MILES
		3—3,000 MILES

RA PD 14323

Figure 41—Lubrication of Suspension System and Turret

LUBRICATION


Lubricant • Interval
Interval • Lubricant
Gun tube (finished surface) OE D (Note 6)
OE Gun bore (Note 7)
Cradle trunnion bearing WB (Note 9)
M OG Firing cable conduit
M OG Cradle liner
Cylinder anchor pin OG M
WB Cradle trunnion bearing (Note 9)
Piston rod bearing OE M
M OG Firing cable conduit
D OE Elevating rack and pinion (Note 4)
Recoil mechanism (Note 3)
OG Elevating gear case (Note 9)
Gear case hub brg. OE M
OH Hydraulic oil reservoir (Keep to level on glass gage)
Worm and wheel OE M (Remove cover, coat teeth)
D OE Breech and firing mechanism (Note 5)
KEY

LUBRICANTS		INTERVALS
OE—OIL, engine SAE 30 (above +32°) SAE 10 (below +32°)	**WB**—GREASE, general purpose No. 2	D—DAILY
OG—GREASE, O.D. No. 0 (above +32°) No. 00 (below +32°)	**OH**—OIL, hydraulic	M—MONTHLY

1. **FITTINGS** — Clean before applying lubricant. Where bearings can be seen, lubricate fittings until new grease is forced from the bearing.
2. **INTERVALS** — The intervals indicated are for normal service. For extreme conditions of heat, dust, etc., reduce interval on guide by 1/3 or 1/2, or more if conditions warrant.
3. **RECOIL FLUID** — For instructions on quantity and application of recoil fluid, refer to Par. 21, FM 23-95. Use **OIL,** recoil, heavy.
4. **ELEVATING RACK AND PINION** — Clean and apply **OIL,** engine, seasonal grade, daily.
5. **BREECH AND FIRING MECHANISM** — Clean and oil all moving parts and exposed metal surfaces with **OIL,** engine, seasonal grade, daily. Perform operation before and after firing. **CAUTION:** To insure easy breech operation and to avoid misfiring in cold weather, clean with **SOLVENT,** dry-cleaning, dry and lubricate with **OIL,** lub., for aircraft instruments and machine guns. To clean firing mechanism, remove and operate pin in solvent.
6. **GUN TUBE** (finished surface) — Clean and oil exposed finished metal surface daily and before firing. Keep surface covered with thin film of **OIL,** engine, seasonal grade.
7. **GUN BORE** — Clean and coat with **OIL,** engine, seasonal grade, after firing. Inspect daily and oil if necessary.
8. **OIL CAN POINTS** — Lubricate the following points weekly with **OIL,** engine, seasonal grade: Handwheel handles, firing button, firing lever link, etc.
9. **POINTS TO BE LUBRICATED BY ORDNANCE MAINTENANCE PERSONNEL AT TIME OF ORDNANCE INSPECTION** — Cradle trunnion bearings, elevating gear case, gun stabilizer and turret traversing mechanism.

RA PD 51352

Figure 42—Lubrication of Combination Gun Mount M34

35. TABLE OF CAPACITIES WITH RECOMMENDATIONS AT TEMPERATURES SHOWN.

a. Table.

	Capacity	Above +32 F	+32 F to +10 F	+10 F to −10 F	Below −10 F
Engine oil tank	36 qt				
Transmission, differential and final drive (single unit)	152 qt	OE	OE	OE	Refer to OFSB 6-11
Transmission and differential (3-piece unit)	64 qt	SAE 50	SAE 30	SAE 30	
Final drives (each) (3-piece unit)	36 qt				

b. Cold Weather. For lubrication and service below −10 F, refer to OFSB 6-11.

36. ENGINE LUBRICATION SYSTEM (figs. 43, 44, and 45).

a. In the engine lubrication system (fig. 43) the main oil supply is kept in an external tank, located at the right rear of the fighting compartment just ahead of the bulkhead. Oil is drawn from the bottom of this tank by means of the engine oil pump, entering through a finger strainer and being forced through the engine lubrication system. Oil returns to a sump which is emptied by a main scavenging line and a front scavenging line. Before returning to the engine oil tank, the oil is forced through a disk-type filter and then through an engine oil cooler, located on the fighting compartment side of the bulkhead just to the left of the oil tank. This cooler is equipped with a bypass to allow thick, cold oil to circulate without passing through the cooler. From the cooler the oil enters the tank through an expansion hopper at the right side of the oil tank.

b. To relieve pressure from the oil tank, and to vent foam from the expansion hopper, a breather line is provided from the tank to the accessory case of the engine (in some tanks the breather is vented externally instead of through the engine). The engine breathes internally, accessory case pressure being relieved through drilled passages to the crankcase section. The crankcase is vented through a breather line into the left air intake pipe (or in some models to a specially filtered vent pipe at the top of the engine).

c. The oil tank is filled through a filler pipe on the top of the oil tank. The filler cap is equipped with a bayonet gage (fig. 44) to indicate the amount of oil in the tank. A drain plug is located in the bottom of the oil tank. To drain the tank, it is necessary to remove the cover plate in the hull floor directly below the tank, and then remove the drain plug.

LUBRICATION

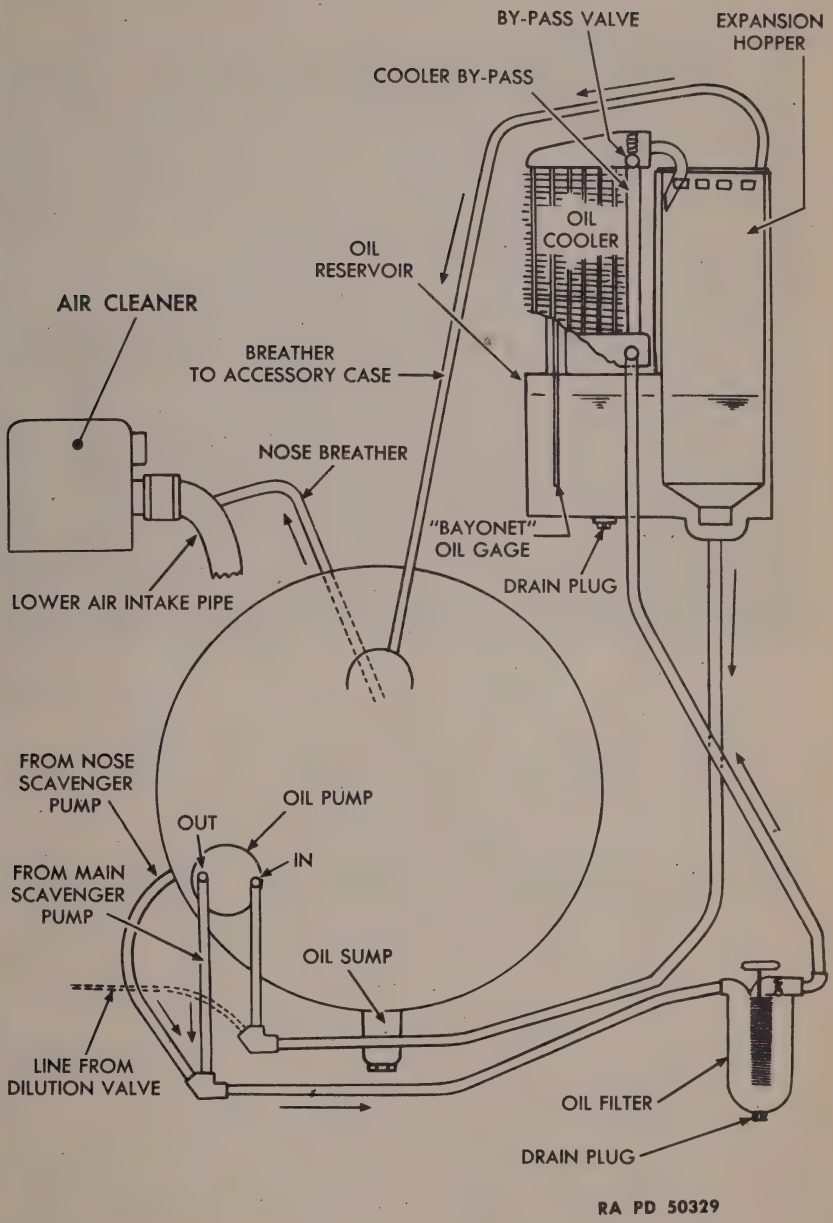


Figure 43—Engine Lubrication System

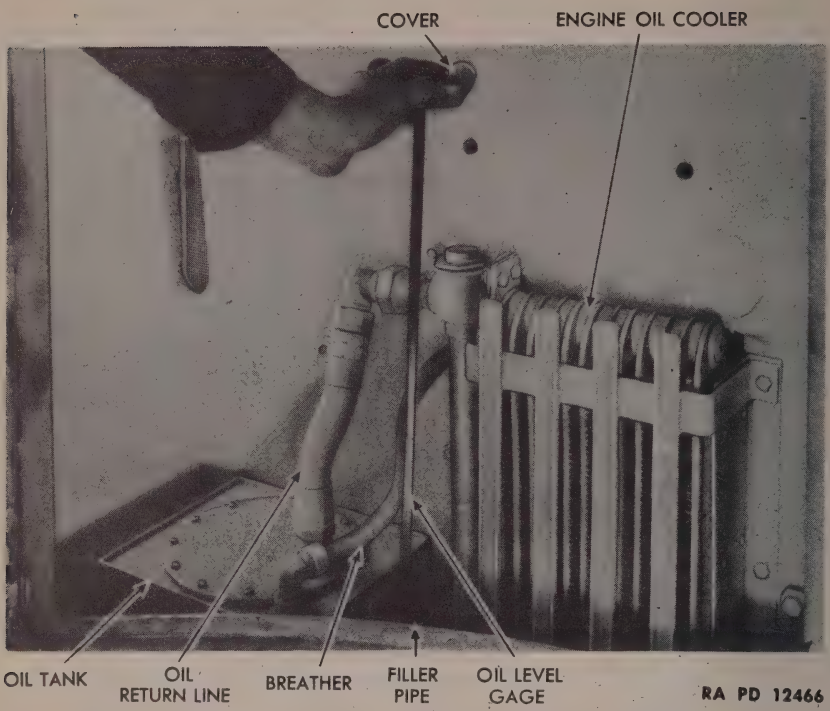


Figure 44—Checking Engine Oil Supply with Bayonet Gage

DILUTION TIME

ANTICIPATED TEMPERATURE	MINUTES	DILUTION CYCLES
0	2	—
—10	2-1/2	—
—15	3	—
—20	3-1/2	1
—30	—	2
—40	—	3

RA PD 53968

Figure 45—Oil Dilution Table

d. The disk type oil filter is self-cleaned by turning the handle on the top of the cover. This should be done daily (fig. 13). For further cleaning of this type of filter, see section XVII, paragraph 85.

Anticipated temperature	Dilution time Minutes	Dilution cycles
0	2	–
—10	2½	–
—15	3	–
—20	3½	1
—30	–	2
—40	–	3

e. Oil Dilution System. Two methods of oil dilution are used. The latest system employs an oil dilution tank; the earlier one uses an oil dilution valve.

(1) The oil dilution tank has a visible gage to show when it is full. To use the tank, depress the handle until the dilution tank is full. Raise the handle to allow the oil to flow into the engine oil reservoir. This completes one cycle. In this system there is an oil immersion heater in the engine oil tank which heats the oil sufficiently, eliminating the need for dilution above —20 F. However, lower than —20 F requires dilution as explained above.

(2) The oil dilution valve, which is solenoid-actuated, is located on the left side of the engine support beam. The solenoid is operated by a toggle switch on the instrument panel. When open, the valve allows gasoline to flow through a line from the carburetor into the main oil inlet line, thus diluting the oil. The oil dilution valve should be checked frequently, to be sure that it completely shuts off the gasoline line when the switch is in the "OFF" position.

Section VII

CARE AND PRESERVATION

	Paragraph
Records	37
Cleaning	38
Preventive maintenance	39

37. RECORDS.

a. Use. An accurate record must be kept of each motor vehicle issued by the Ordnance Department. For this purpose the Ordnance Motor Book (O.O. Form No. 7255), generally called "Log Book," is issued with each vehicle and must accompany it at all times. This book furnishes a complete record of the vehicle from which valuable information concerning operation and maintenance costs, etc., is obtained and organization commanders must insist that correct entries be made. This book will habitually be kept in a canvas cover to prevent its being injured or soiled.

b. Assignment Record. The page bearing a record of assignment must be destroyed prior to entering the combat zone. All other references which may be posted regarding the identity of the organization must also be deleted.

38. CLEANING.

a. Grit, dirt, and mud are the sources of greatest wear to a vehicle. If deposits of dirt and grit are allowed to accumulate, particles will soon find their way into bearing surfaces, causing unnecessary wear, and, if the condition is not remedied, will soon cause serious difficulty. When removing engine parts or any other unit, in making repairs and replacements, or, if in the course of inspection, working joints or bearing surfaces are to be exposed, all dirt and grit that might find its way to the exposed surfaces must first be carefully removed. The tools must be clean, and care must always be taken to eliminate the possibilities of brushing dirt or grit into the opening with the sleeve or other part of the clothing. To cut oil-soaked dirt and grit, hardened grit, or road oil, use SOLVENT, dry-cleaning, applied with cloths (not waste) or a brush. Care should be taken to keep water from the power unit, as it might interfere with proper ignition and carburetion. Detailed information on cleaning is included in TM 9-850.

b. Oilholes which have become clogged should be opened with a piece of wire. Wood should never be used for this purpose, as splinters are likely to break off and permanently clog the passages. Particular care should be taken to clean and decontaminate vehicles that have been caught in a gas attack. See section IX, "Materiel Affected by Gas," for details of this operation.

39. PREVENTIVE MAINTENANCE (figs. 46, 47, 48, 49, and 50).

a. General. Preventive maintenance is a combination of all things which contribute to the long life and continued efficiency of the tank, and is the unceasing responsibility of every member of the crew. It includes all such items as cleaning, inspections, lubrication adjustments, and proper operation. With the right kind of care the tank will continue to be an effective, hard-hitting combat unit, dangerous to the enemy and offering maximum protection to its crew. But neglect, even of seemingly unimportant items, is one of the surest ways of putting both the tank and its crew out of action. The illustrations included in this section show the kind of damage that lack of preventive maintenance can cause.

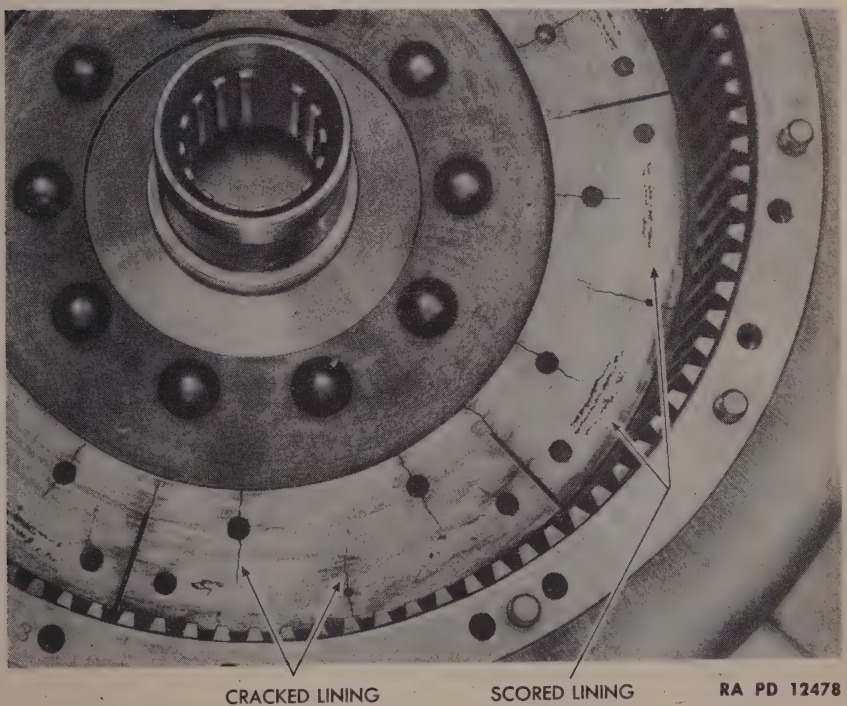


Figure 46—Clutch Lining Scored and Cracked from Overheating

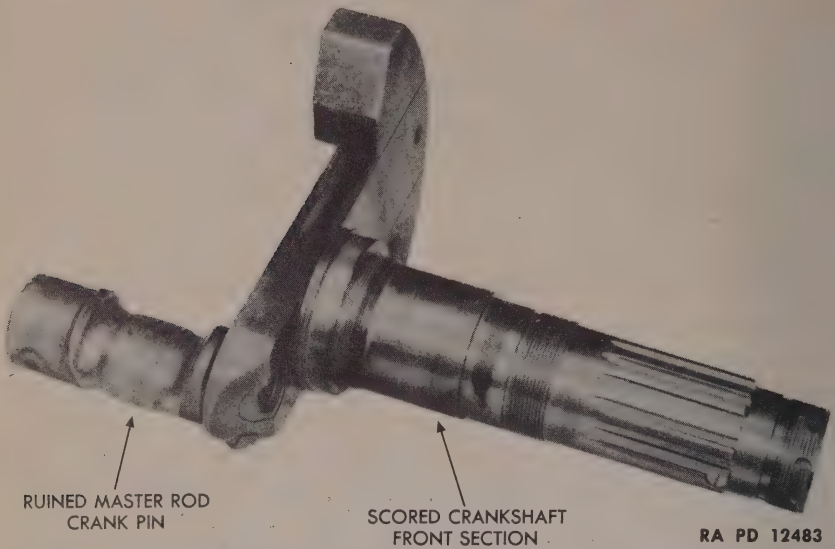


Figure 47—Master Rod Crank Pin Ruined by Overheating and Lack of Lubrication

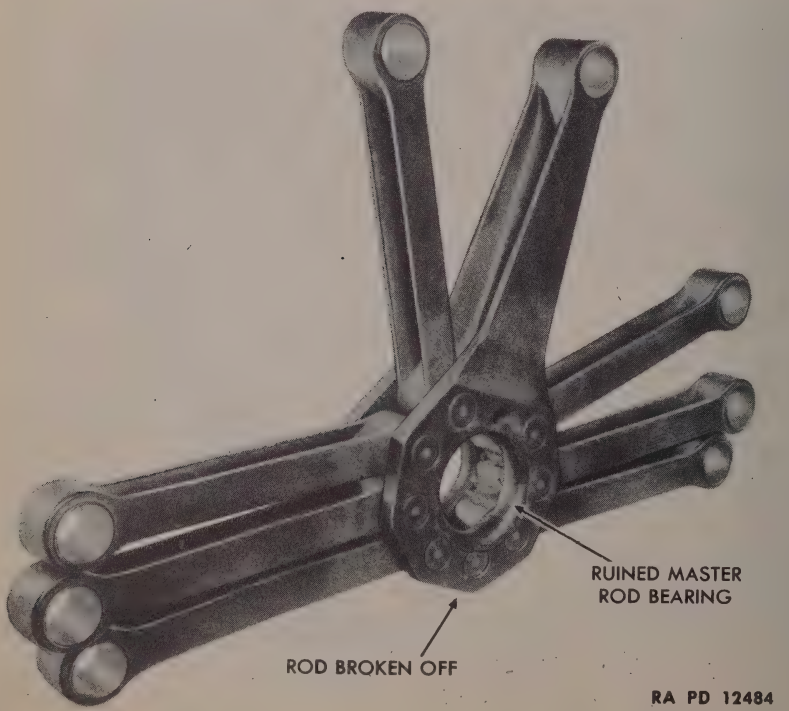


Figure 48—Condition of Master Rod Bearing from Same Engine as in Figure 47

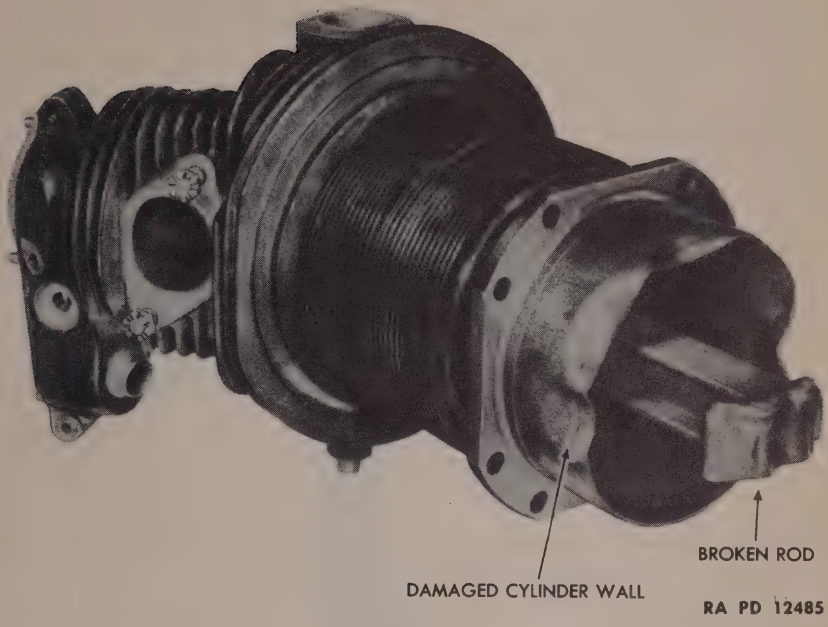
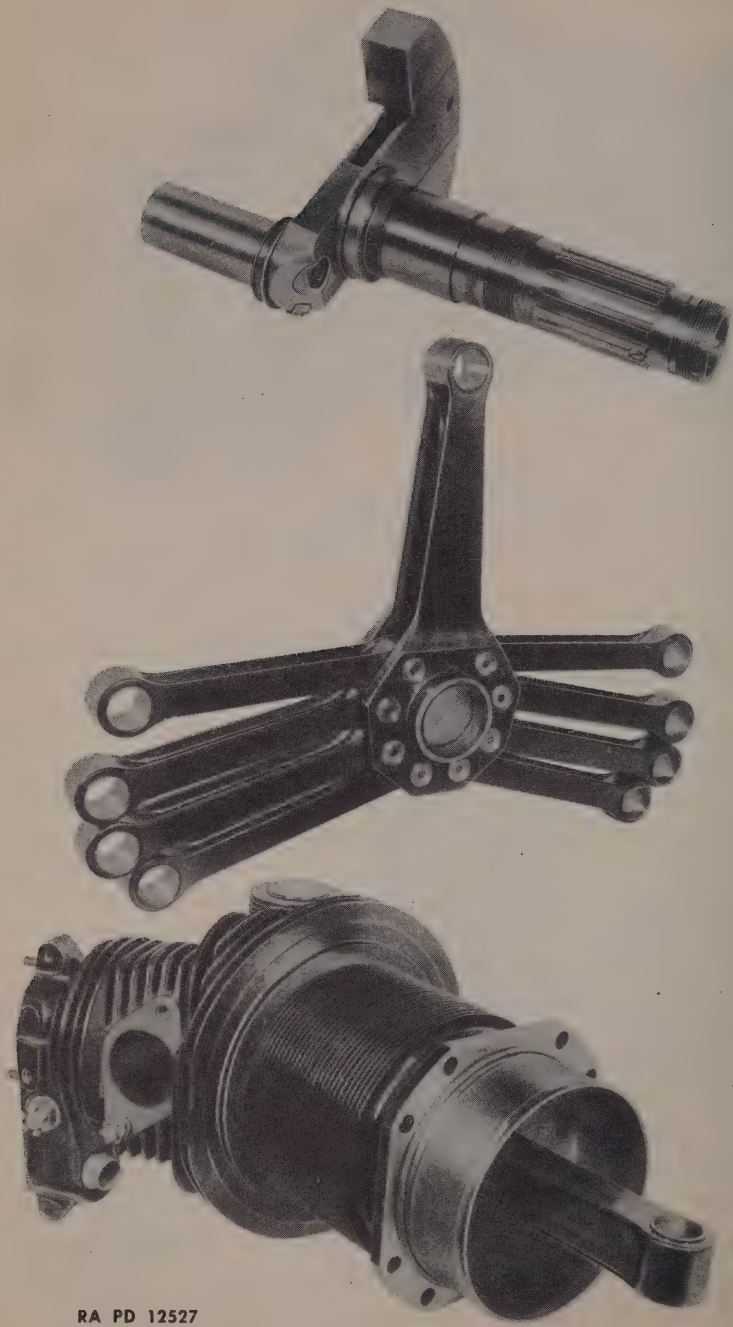


Figure 49—Cylinder and Broken Rod Removed from Same Engine as Parts Shown in Figure 47 and Figure 48

b. Example I—Allowing Clutch to Overheat. This may be caused by failure to keep the clutch linkage in proper adjustment or it may be due to constant slipping and riding of the clutch by the driver. Whatever the cause of an overheated clutch, the results are clearly shown in figure 46. While the clutch lining was almost new and should normally have given many days or months of operation without replacement, it was completely ruined in less than a week of relatively light maneuvers. Notice the deep score marks and the discoloration. In addition, the lining is cracked at almost every rivet and at the end of each segment. Assuming that the driver in this case was not at fault, the destruction of this clutch could have been averted by making the simple and easy inspections and adjustments necessary to maintain the correct amount of free play in the clutch pedal linkage. Instead, the tank was out of action, the engine had to be removed, and the entire clutch had to be replaced. Time is never so short that inspections and adjustments can be neglected.

c. Example II—Neglecting the Engine.

(1) The three engine parts illustrated in figures 47, 48, and 49 show clearly the extent to which an engine can be irreparably damaged by lack of alertness on the part of the driver or the crew. For purposes of comparison, a set of undamaged parts are shown in figure 50. Although the



RA PD 12527

Figure 50—Perfect Parts from an Undamaged Engine

immediate cause of the damage to this engine may have been due to loss of oil pressure, inspection of the engine showed that it had also been subjected to excessive heat due to failure to remove dirt and refuse from around the lower cylinders, and the intercylinder baffles.

(2) The crankshaft in figure 47 shows how the master rod crankpin was nearly melted away. The front section of the shaft also was seriously scored and worn.

(3) The master rod assembly in figure 48 shows how the bearing was almost completely destroyed. Note also that one rod is missing.

(4) The cylinder containing the broken rod is shown in figure 49. Notice how the rod spread opens at the bearing, with the ends turning back on the rod, severely damaging the lower end of the cylinder wall. Except for a few accessories, there was practically no salvage possible from an engine that a few seconds before this happened was a highly efficient power plant. Preventive maintenance would have prevented this waste of vital equipment.

MEDIUM TANKS M4 AND M4A1

Section VIII

TOOLS AND EQUIPMENT ON VEHICLE

Paragraph
Tools and equipment 40
Use of special equipment (fire extinguishers) 41

40. TOOLS AND EQUIPMENT.

a. General. The tank comes complete with a set of pioneer tools, generally carried on the hull, a special set of repair tools, and a number of special equipment items which are stowed inside the tank. A list of this equipment and its location on the tank is given below.

b. Description.

(1) ARMAMENT.

Equipment	Stowage Position
GUN, 75-mm, M3, in Mount, M34 (1)	Mount located in turret, 360 deg traverse.
GUN, machine, cal. .30, Model 1919A4 (flexible) (1)	Coaxial with 75-mm in turret.
GUN, machine, cal. .30 model 1919A4 (flexible) (1)	Flexible bow gun.
GUN, machine, Browning, cal. .50, M2, H.B. (flexible) (1) or GUN, machine, cal. .30 Model 1919A4 (flexible) (1)	Barrel, receiver and antiaircraft mount, disassembled as separate units, carried inside turret and to the right and rear of the 75-mm gunner.
GUN, submachine, cal. .45, Model 1928A1 (1)	In clip, top rear of turret, above radio.
MOUNT, tripod, machine gun, cal. .30, M2 (1)	Right side of hull, rear of bow-gunner seat.

(2) AMMUNITION.

75-mm, 90 rounds 4 additional rounds stowed in place of cal. .50 ammunition when cal. .50 machine gun is replaced by cal. .30 machine gun.	8 rounds—left sponson forward of tool box. 15 rounds—right sponson forward of cal. .50 ammunition boxes. 17 rounds—right sponson to right of bow gunner. NOTE: Removed for installation of radio set SCR 506. 30 rounds—on floor under turret basket to rear of escape door. 8 rounds—on turret basket floor. 12 rounds—in ready clips around turret basket inside.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
Cal. .50, 300 rounds	150 rounds—in three 50-round boxes right sponson forward of engine bulkhead. 150 rounds—in three 50-round boxes strapped to turret basket floor.
Cal. .30, 6,750 rounds	4,500 rounds—in eighteen 250-round expendable boxes, on floor, forward of battery box, under turret basket. 1,750 rounds—in seven 250-round expendable boxes, on turret basket floor under 75-mm gun. 250 rounds—one 250-round expendable box on feed rack of bow gun. 250 rounds—one 250-round expendable box on feed rack of coaxial gun.
Cal. .45, 600 rounds	600 rounds—in twenty 30-round clips in submachine gun bracket above turret radio.
GRENADES, hand (12):	4 fragmentation, 2 offensive and 2 smoke in box under 75-mm gunner's seat.
Fragmentation, MK2 (4) Smoke, HC, M8 (4) Offensive, MK .111 w/fuze, detonation, hand grenade, M6A2 (2) Incendiary, M14 (2)	2 smoke and 2 incendiary in box, left side turret wall.
(3) SIGNAL EQUIPMENT.	
RADIO SET, type III, SCR-508	In turret bulge.
RADIO SET, type II, SCR-506	In right sponson (command tanks only) (Displace 17 round, 75-mm ammunition right front sponson).
CASE, CS-16 (1)	In turret, left of commander seat.
FLAG, set, M238 (tank) (1)	In turret, left of commander seat.
LIGHT, recognition (when provided)	In turret (command tank only).

MEDIUM TANKS M4 AND M4A1

Equipment	Stowage Position
ANTENNA, complete (spare) with cover (1) and	In bracket, right side of sponson.
BASE, mast with cover, MP37 or MP48 (1)	
(4) Fire Fighting and Antigas Equipment.	
EXTINGUISHER, fire, 4 lb Co_2, (portable) (2)	1 in left sponson next to driver, 1 in turret in front of 75-mm loader's seat.
EXTINGUISHER, fire 10 lb Co_2, (fixed) (2)	Left rear fighting compartment.
APPARATUS, decontaminating, 1½ qt (1)	Left side of hull to rear of driver's seat.
(5) Rations.	
RATIONS type "C" for 5 men, 60 cans (2 days')	In box under turret cage, right side of power tunnel.
RATIONS, type "D" for 5 men, 2 cans, (24 bars) (1 day's)	In box under turret cage, right side of power tunnel.
(6) Water.	
CONTAINER, water 5 gal. (Q.M. C. Standard) (2)	Left sponson in front of Homelite Generator set.
CANTEEN, M1910, with cup and cover (5)	3 in turret bracket on left side, 2 in hull, 1 on right, and 1 on left side.
(7) Equipment.	
KIT, first-aid (24 unit) (1)	Left sponson, next to portable fire extinguisher.
HELMET, tank sizes 7, 7⅛, 7¼, 7⅜, 7½ (5)	On individuals.
TUBE, flexible, nozzle (2)	Tool box, under turret cage.
FLASHLIGHT (3)	Clip in hull on front plate between driver and bow gunner, 1 in turret right of radio bulge, 1 in turret above 75-mm gun.
MITTENS, asbestos, pair (2)	1 in oddment tray in turret; 1 in bow gunner's cal. .30 spare parts box.
BUCKET, canvas, folding, w/spout 8 qt (1)	Right sponson, front of 75-mm rear ammunition rack.
GOGGLES, aviation type MC	On individuals.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
BAG, canvas, field OD, M-1936 (5)	On battery box, under turret.
ROLL, blanket (5)	Inside, over escape hatch.
RESPIRATOR, dust (5)	On individuals.
COMPASS (Hull) (1)	In turret.
BINOCULAR, M3, complete (1) Composed of: BINOCULAR, M3 (1) CASE, carrying (1) STRAP, neck (1)	On turret wall in bracket, right of 75-mm gunner.
PERISCOPE, M3 or M4 (spare) (w/telescope) (1)	75-mm gunner's spare periscope, in box to right of seat on turret sub-floor.
PERISCOPE, M6 (spare) (or later models) (4)	Driver's spare periscope, in box left sponson near dash panel. Bow gunner spare periscope, in box under seat. Commander's spare periscope, in box rear of 75-mm gunner's seat. 75-mm loader's spare periscope in box on basket wall, forward of seat.
HEAD, periscope, M5 and/or M3 (spare) (15) (21 on later models)	Three spare heads in each spare periscope box, listed above.

(8) Spare Parts and Accessories for Guns and Vehicles.

(a) 75-mm Gun.

1. Spare Parts.

FORK, cooking (1)	In right box, at feet of 75-mm gunner.
MECHANISM, percussion, assembly (1) Composed of: GUIDE (1) PIN (1) SPRING (1) STOP (1) PIN (1)	In right box, at feet of 75-mm gunner.

MEDIUM TANKS M4 AND M4A1

Equipment	Stowage Position
PLUNGER, cocking fork (1)	In right box, at feet of 75-mm gunner.
PLUNGER, firing, (1)	In right box, at feet of 75-mm gunner.
RETAINER, firing plunger (1)	In right box, at feet of 75-mm gunner.
RETAINER, sear (1)	In right box, at feet of 75-mm gunner.
SPRING, compression, S., .037 dia. stock .190 O.D. 9 coils (1)	In right box, at feet of 75-mm gunner.
PIN, firing (2)	In right box, at feet of 75-mm gunner.
STOP, firing spring (3)	In right box, at feet of 75-mm gunner.
PLUG, recoil cylinder (2)	In right box, at feet of 75-mm gunner.
PIN, cotter, split, S., $\frac{1}{8}$ x $1\frac{3}{4}$ (6)	In right box, at feet of 75-mm gunner.
2. Accessories.	
POUCH, spare parts roll w/o contents (1)	In right box, at feet of 75-mm gunner.
CAN, oil, 1 qt $5\frac{5}{8}$ x $4\frac{3}{16}$ x $2\frac{11}{16}$ (1).	In rack under bow gunner's seat.
OIL, recoil, heavy (low pour point) qt (1)	In can listed above.
COVER, breech (1)	On gun.
COVER, muzzle (1)	On gun.
COVER, periscope (1)	On periscope.
BOOK, artillery gun, O.O. Form 5825 (blank) (1)	In right box, feet of 75-mm gunner.
BRUSH, bore, M10, w/staff (1) Consisting of:	Cal. .30 spare parts box, right sponson.
BRUSH, bore, M10 (1)	
STAFF, end (1)	Right sponson above 75-mm ammunition rack.
STAFF, middle (1)	Right sponson above 75-mm ammunition rack.
COVER, bore brush, M516 (1)	On brush.
CASE, carrying, gunner's quad, M1 (1)	In bracket right side of hull, forward of rear 75-mm ammunition rack.
QUADRANT, gunner's, M1 (1)	In case.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
SETTER fuze, M14 (1)	In right box, at feet of 75-mm gunner.
WRENCH, fuze (1)	In right box, at feet of 75-mm gunner.
TARGET, testing (6)	Cal. .30 spare parts box, right front sponson.

(b) Cal. .50 Machine Gun. In tanks where cal. .50 has been replaced by cal. .30 machine gun, these parts will not be supplied.

1. Spare Parts.

EXTRACTOR, assembly (1)	In center box, at feet of 75-mm gunner.

2. Accessories

BOX, ammunition (50 rd., cal. .50) (6)	3 boxes in turret on floor. 3 boxes in right sponson.
BRUSH, cleaning, cal. .50 M4 (1)	In center box, at feet of 75-mm gunner.
COVER, gun and cradle, M10 (1)	On gun.
ROD, jointed, cleaning, M1 (1)	In center box, at feet of 75-mm gunner.
WRENCH, combination, Cal. .50, M2 (1)	In center box, at feet of 75-mm gunner.

(c) Cal. .30 Machine Gun.

1. Spare Parts.

BARREL, spare (2)	Left side of hull to left of cal. .30 ammunition rack.
ACCELERATOR (2)	*2 cal. .30 spare parts boxes, 1 box by bow gunner, right sponson. 1 box center, feet of 75-mm gunner.
BOLT, assembly (2)	2 cal. .30 spare parts boxes.
BUSHING, belt feed lever pivot (1)	2 cal. .30 spare parts boxes.
CAP, belt feed, lever pivot (1)	2 cal. .30 spare parts boxes.
EXTENSION, barrel assembly (1)	2 cal. .30 spare parts boxes.
EXTRACTOR, assembly (2)	2 cal. .30 spare parts boxes.
LEVER, cocking (1)	2 cal. .30 spare parts boxes.
LEVER, feed, belt (1)	2 cal. .30 spare parts boxes.
LOCK, breech (1)	2 cal. .30 spare parts boxes.

* Distribute as desired between two stowage positions.

Equipment	Stowage Position
NUT, belt feed lever pivot bushing (1)	2 cal. .30 spare parts boxes.
PAWL, feed, belt (2)	2 cal. .30 spare parts boxes.
PIN, accelerator, assembly (2)	2 cal. .30 spare parts boxes.
PIN, belt feed pawl, assembly (2)	2 cal. .30 spare parts boxes.
PIN, belt holding pawl, split (2)	2 cal. .30 spare parts boxes.
PIN, cocking lever (1)	2 cal. .30 spare parts boxes.
PIN, driving spring rod (1)	2 cal. .30 spare parts boxes.
PIN, firing, assembly (2)	2 cal. .30 spare parts boxes.
PIN, trigger (1)	2 cal. .30 spare parts boxes.
TRIGGER, (1)	2 cal. .30 spare parts boxes.
ROD, driving spring assembly (1)	2 cal. .30 spare parts boxes.
SEAR (2)	2 cal. .30 spare parts boxes.
SLIDE, feed, belt, assembly (1)	2 cal. .30 spare parts boxes.
SPRING, belt feed pawl (1)	2 cal. .30 spare parts boxes.
SPRING, belt holding pawl (1)	2 cal. .30 spare parts boxes.
SPRING, driving (1)	2 cal. .30 spare parts boxes.
SPRING, cover extractor (2)	2 cal. .30 spare parts boxes.
SPRING, locking, barrel (1)	2 cal. .30 spare parts boxes.
COVER, assembly (1)	2 cal. .30 spare parts boxes.
PIVOT, belt feed lever (1)	2 cal. .30 spare parts boxes.

2. Accessories.

CHEST, ammunition, cal. .30 (27)	In hull and in turret.
COVER, tripod, mount, M2	On tripod.
COVER, muzzle, cal. .30 (flex. bow gun) (1)	On gun.
COVER, muzzle, cal. .30 (turret) (1)	On gun.
COVER, receiver, cal. .30 (flex. bow gun and turret, cal. .30) (2)	On gun.
BAG, empty cartridge, cal. .30 (flex. bow gun) (1)	On gun.
BAG, empty cartridge, cal. .30 (turret) (1)	On gun.
SCREWDRIVER, combination, M1 (2)	In 2 cal. .30 spare parts boxes.
WRENCH, combination, M6 (2)	In 2 cal. .30 spare parts boxes.
WRENCH, socket, front barrel bearing plug (1)	In 2 cal. .30 spare parts boxes.
CASE, spare bolt, M2, w/o contents (2)	In 2 cal. .30 spare parts boxes.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
EXTRACTOR, ruptured cartridge, MK IV (2)	In 2 cal. .30 spare parts boxes.
BRUSH, chamber cleaning, M6 (1)	In 2 cal. .30 spare parts boxes.
BRUSH, cleaning, cal. .30, M2 (6)	In 2 cal. .30 spare parts boxes.
CAN, tubular, w/o contents (1)	In 2 cal. .30 spare parts boxes.
ENVELOPE, spare parts, M1, w/o contents (2)	In 2 cal. .30 spare parts boxes.
OILER, rect. 12 oz (1)	In 2 cal. .30 spare parts boxes.
REFLECTOR, barrel, cal. .30 (1)	In 2 cal. .30 spare parts boxes.
ROD, cleaning, jointed, cal. .30, M1 (2)	In 2 cal. .30 spare parts boxes.
ROLL, spare parts, M13, w/o contents (1)	In 2 cal. .30 spare parts boxes.
ROLL, tools, M12, w/o contents (1)	In 2 cal. .30 spare parts boxes.

(d) Cal. .45 Sub-Machine Gun.

1. Spare Parts.

DISCONNECTOR, (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
EJECTOR, (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
EXTRACTOR, (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
PIN, firing (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
ROCKER, (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
SPRING, disconnector (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
SPRING, firing pin (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
SPRING, magazine catch (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.

Equipment	Stowage Position
SPRING, recoil (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
SPRING, sear (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
2. Accessories.	
SLING, gun, M1923 (webbing) (1)	On gun.
THONG, (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
BRUSH, chamber cleaning, M6 (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
BRUSH, cleaning, cal. .45, M5 (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
CASE, accessories and spare parts, M1918, w/o contents (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
ENVELOPE, fabric, one button 3x3⅛ (1)	In case, accessory, stowed in cal. .30 center box, at feet of 75-mm gunner.
MAGAZINE, 30 rd (Clips) (20)	In sub-machine gun rack above radio.
(e) Vehicle.	
1. Spart Parts.	
CONNECTION, track shoe end (12)	Tool box, under turret, right side.
LAMP, bulb, 3 CP, 24-28V (4)	Tool box, under turret, right side.
BLOCK, track shoe, link (6)	Tool box, under turret, right side.
NUT, safety, alloy-S., ⅝-18-NF-3 (16)	Tool box, under turret, right side.
PIN, cotter, split, S, (Type B), ¼x2¼ (for tow shackle pin) (2)	Tool box, under turret, right side.
WEDGE, track shoe and connection (12)	Tool box, under turret, right side.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
2. Accessories.	
CRANK, engine (1)	In clips on bustle, or right side of power tunnel.
CABLE, towing, (1)	Over left side of vehicle, outside.
PADLOCK, 1½, 2 keys (1)	On driver's door.
HOOD, hatch, driver's (1)	Inside on hull, between driver and bow gunner.
NET, camouflage, 45 ft x 45 ft (1)	Rear deck.
LAMP, inspection (1)	Tool box, left sponson.
BULB, lamp, inspection (1)	Tool box, left sponson.
TARPAULIN, 12 ft x 12 ft (1)	Outside rear of turret.
GROUSER (when track is used) (26)	Grouser box near mufflers. Not used with steel track.
CAN, oil, 1 qt (engine oil emergency) (8)	Brackets are being provided in engine compartment.
CAN, oil, 1 qt 5⅝ x 4 3/16 x 2 11/16 (1) (traverse and stabilizer)	In right box at feet of 75-mm gunner.
OIL, quart, oil, hydraulic (1)	In can above.
CAN, oil, trigger type 1 pt (1)	On floor, under bow gunner's seat.
War Department lubrication guides, No. 84 and 58A (1)	In bracket.
Book, O.O. Form 7255 (1)	Tool box, left sponson.
Technical manual 9-757 (1)	Tool box, left sponson.
Technical manual for 75-mm gun, M3 TM 9-307	Tool box, left sponson.
Technical manual 11-600 (1)	Tool box, left sponson.
Field manual for cal. .30 M.G. 1919A4, FM 23-50 (1)	Tool box, left sponson.
Field manual for cal. .45 S.M.G. 1928A FM 23-40 (1)	Tool box, left sponson.
Field manual for cal. .50 M.G. M2, FM 23-65 (1)	Tool box, left sponson.
Field manual for hand grenades FM 23-30 (1)	Tool box, left sponson.
Field manual for 75-mm Tank Gun, 142 FM 23-95 (1)	Tool box, left sponson.
TAPER, friction ¾-in. wide 30 ft roll (1)	Tool box, left sponson.
MATTOCK, pick, M1, 4 lb head w/handle (1)	Rear deck.

MEDIUM TANKS M4 AND M4A1

Equipment	Stowage Position
SHOVEL, D.H., round point (1)	Rear deck.
SLEDGE, blacksmith, dble. face, 10 lb (1)	Rear deck.
ADAPTER, button head to bayonet type (1)	In tool box, left sponson, ahead of water can.
ADAPTER, button head to hydraulic type (1)	In tool box, left sponson, ahead of water can.
BAG, tool, (1)	In tool box, left sponson, ahead of water can.
FIXTURE, track connecting (1)	In tool box, left sponson, ahead of water can.
GUN, lub., high pressure lever type, 1 lb (1)	In tool box, left sponson, ahead of water can.
HAMMER, machinist, ball peen, 2 lb (1)	In tool box, left sponson, ahead of water can.
HOSE, lub., 5 in., heavy duty, button head fitting (1)	In tool box, left sponson, ahead of water can.
PLIERS, combination, slip joint, 8 in. (1)	In tool box, left sponson, ahead of water can.
PLIERS, side cutting, 8 in. (1)	In tool box, left sponson, ahead of water can.
SCREWDRIVER, mach., extra heavy duty, 5 in. blade (1)	In tool box, left sponson, ahead of water can.
SCREWDRIVER, close quarter, 1¾ in. blade (1)	In tool box, left sponson, ahead of water can.
SCREWDRIVER, wood handle, ¼ in. blade, 3½ in. long (1)	In tool box, left sponson, ahead of water can.
WRENCH, adjustable, single-end, 12 in. (1)	In tool box, left sponson, ahead of water can.
WRENCH, adjustable, single-end, 8 in. (1)	In tool box, left sponson, ahead of water can.
WRENCH, engr. dble. head, alloy S., (6) Sizes as follows: $\frac{5}{16}$ x $\frac{3}{8}$ $\frac{7}{16}$ x $\frac{1}{2}$ $\frac{9}{16}$ x $\frac{11}{16}$ $\frac{5}{8}$ x $\frac{3}{4}$ $\frac{13}{16}$ x $\frac{7}{8}$ $\frac{15}{16}$ x 1	In tool box, left sponson, ahead of water can.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
WRENCH, safety screw (9) Sizes as follows:	In tool box, left sponson, ahead of water can.
$\frac{3}{32}$ hex.	
$\frac{1}{8}$ hex.	
$\frac{3}{16}$ hex.	
$\frac{5}{16}$ hex.	
$\frac{1}{4}$ hex.	
$\frac{3}{8}$ hex.	
$\frac{5}{8}$ hex.	
$\frac{9}{16}$ hex. (transmission and oil tank drain plugs)	
$\frac{3}{4}$ hex. (for differential filler and drain plug)	
SET, wrench, socket, heavy duty, alloy steel, 20 pieces complete:	In tool box, left sponson, ahead of water can.
TEE, combination, $\frac{3}{4}$ in. sq. drive, 17 in. (1)	
TEE, combination, $\frac{1}{2}$ in. sq. drive, 11 in. (1)	
EXTENSION, handy grip, $\frac{1}{2}$ in. sq. drive, 5 in. (1)	
EXTENSION, $\frac{1}{2}$ in. sq. drive, 10 in. (1)	
HANDLE, flexible, $\frac{1}{2}$ in. sq. drive, 12 in. (1)	
RATCHET, $\frac{1}{2}$ in. sq. drive, 9 in. (1)	
JOINT, universal, $\frac{1}{2}$ in. sq. drive, (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{3}{8}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{7}{16}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{1}{2}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{9}{16}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{5}{8}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{3}{4}$ in. hex. (1)	
SOCKET HEAD, $\frac{1}{2}$ in. sq. drive, $\frac{7}{8}$ in. hex. (2)	

Equipment	Stowage Position
SOCKET HEAD, ½ in. sq. drive, $1\frac{5}{16}$ in. hex. (2) SOCKET HEAD, ½ in. sq. drive, 1 in. hex. (1) SOCKET HEAD, ½ in. sq. drive, $1\frac{1}{16}$ in. hex. (1) SOCKET HEAD, ½ in. sq. drive, 1⅛ in. hex. (1) SOCKET HEAD, ½ in. sq. drive, 1½ in. hex. (1) SPEEDER, 17 in. (1)	In tool box, left sponson, ahead of water can.
WRENCH, track adjusting, 3.031. hex., opening $44\frac{5}{8}$ in. long (1)	In clips on rear deck.
3. Gun Accessories.	
GUN, recoil oil (1)	In box, left, at feet of 75-mm gunner.
DRIFT, brass, taper (2) $\frac{5}{16}$ in. pt. 4 in. long (1) ½ in. pt. 6 in. long (1)	In box, left, at feet of 75-mm gunner.
EXTENSION, oil gun	In box, left, at feet of 75-mm gunner.
EYEBOLT, breechblock removing (1)	In box, left, at feet of 75-mm gunner.
FILE, A.S. (2) Hand, sm. 8 in. (1) Three-sq. 6 in. (1)	In box, left, at feet of 75-mm gunner.
HAMMER, machs., ball peen, 20 oz. (1)	In box, left, at feet of 75-mm gunner.
PUNCH, drift, ¼ in. pt. 10 in. long (1)	In box, left, at feet of 75-mm gunner.
PUNCH, drive pin, std. ⅛ in. pt. (1)	In box, left, at feet of 75-mm gunner.
ROD, push (for shaft) breechblock removing (1)	In box, left, at feet of 75-mm gunner.
ROLL, tool, M4, w/o contents (1)	In box, left, at feet of 75-mm gunner.

TOOLS AND EQUIPMENT ON VEHICLE

Equipment	Stowage Position
TOOL, breechblock removing (1)	In box, left, at feet of 75-mm gunner.
TOOL, assembling, firing pin retainer (1)	In box, left, at feet of 75-mm gunner.
WRENCH, engrs. dbl. hd. 1¼ x 1½ (for nut necessary in removing breechblock) (1)	In box, left, at feet of 75-mm gunner.
WRENCH, firing plunger retainer (1)	In box, left, at feet of 75-mm gunner.
WRENCH, screw, adj., knf-hdl, 12 in. (1)	In box, left, at feet of 75-mm gunner.
CHISEL, machs, hand, cold, ¾ in. (1)	In box, left, at feet of 75-mm gunner.

41. USE OF SPECIAL EQUIPMENT (FIRE EXTINGUISHERS).

a. Fixed Fire Extinguisher System (figs. 39 and 51).

(1) Two ten-pound fire extinguishers are mounted in special brackets to the left rear of the fighting compartment. They are used solely for extinguishing fires in and around the engine and are connected directly

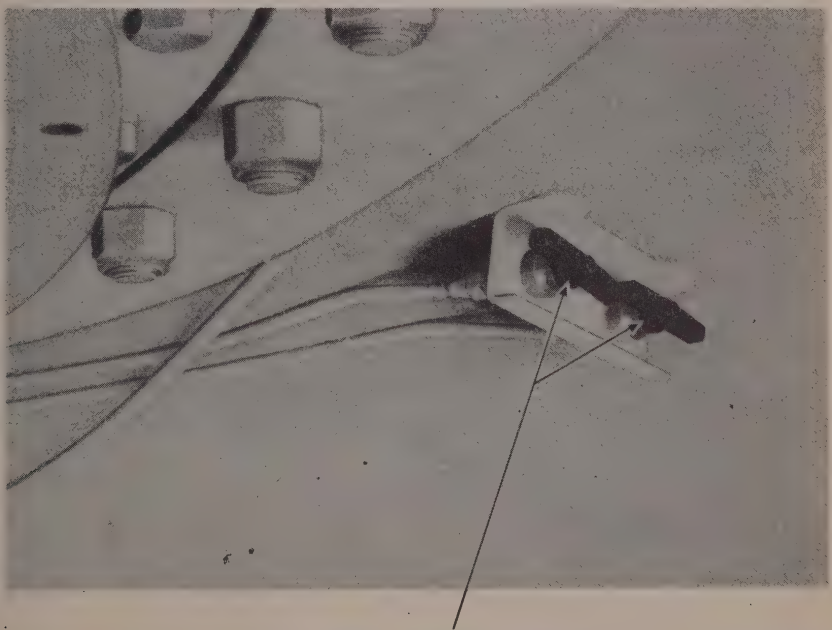


Figure 51—Fire Extinguisher Controls on Left Bow

to lines and horns located in the front and rear of the engine compartment. When put into action, they force carbon dioxide gas around the engine, from top and bottom, and fill the engine compartment, thus smothering the fire. If possible, the engine should be stopped in case of fire.

(2) The fire extinguisher system can be put into operation from inside or outside the tank, by pulling the control handles. The inside handles are located on the hull just above and to the left rear of the driver (fig. 51). The outside handles are on the upper part of the hull, just ahead of the left side of the air inlet (fig. 39).

b. Portable Fire Extinguishers.

(1) Two portable 4-pound fire extinguishers are provided in the tank, one in the left sponson, beside the driver and one at the left side of the turret.

(2) Portable extinguishers are operated by pulling the trigger while directing the discharge cone toward the fire. The position of the trigger determines the rate of discharge. The extinguisher should be carried in the left hand and the hose or cone in the right. Direct the discharge at the base of the flame, with the cone as close to the flame as the operator can safely hold it. Increase the rate of discharge from the extinguisher as the fire is put out.

c. Handling. Any cylinder containing gas under high pressure is as dangerous as a loaded shell. The extinguisher cylinders should never be dropped, struck, handled roughly, or exposed to unnecessary heat.

d. Maintenance.

(1) After use, the extinguisher should be immediately exchanged for one that is fully charged. Every 4 months, or preferably oftener, weigh each extinguisher. If the extinguisher weighs less than 3½ pounds (portable) or 9½ pounds (fixed) it should be exchanged for a fully charged one.

(2) Care should be taken to see that extinguishers are always securely fastened inside the tank, and that stowage is never allowed to be so placed as to interfere with the easy operation of the inside or outside control handles of the fixed fire extinguisher system.

Section IX

MATERIEL AFFECTED BY GAS

	Paragraph
Protective measures	42
Cleaning	43
Decontamination	44
Special precautions for automotive materiel	45

42. PROTECTIVE MEASURES.

a. When materiel is in constant danger of gas attack, unpainted metal parts will be lightly coated with engine oil. Instruments are included among the items to be protected from chemical clouds or chemical shells, but ammunition is excluded. Care should be taken that the oil does not touch the optical parts of instruments or leather or canvas fittings. Materiel not in use will be protected with covers as far as possible. Ammunition will be kept in sealed containers.

b. Ordinary fabrics offer practically no protection against mustard gas or lewisite. Rubber and oilcloth, for example, will be penetrated within a short time. The longer the period during which they are exposed, the greater the danger of wearing these articles. Rubber boots worn in an area contaminated with mustard gas may offer a grave danger to men who wear them several days after the bombardment. Impermeable clothing will resist penetration more than an hour, but should not be worn longer than this.

43. CLEANING.

a. All unpainted metal parts of materiel that have been exposed to any gas except mustard and lewisite must be cleaned as soon as possible with SOLVENT, dry-cleaning, or ALCOHOL, denatured, and wiped dry. All parts should be coated with engine oil.

b. Ammunition which has been exposed to gas must be thoroughly cleaned before it can be fired. To clean ammunition, use AGENT, decontaminating, noncorrosive, or if this is not available, strong soap and cool water. After cleaning, wipe all ammunition dry with clean rags. *Do not use a dry powder AGENT, decontaminating (chloride of lime) (used for decontaminating certain types of materiel on or near ammunition supplies),* as flaming occurs through the use of chloride of lime on liquid mustard.

44. DECONTAMINATION.

a. For the removal of liquid chemicals (mustard, lewisite, etc.) from materiel, the following steps should be taken:

(1) PROTECTIVE MEASURES.

(a) For all of these operations a complete suit of impermeable clothing and a service gas mask should be worn. Immediately after removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. If any skin areas have come in contact with mustard, if even a very small drop of mustard gets into the eye, or if the vapor of mustard has been inhaled, it is imperative that complete first-aid measures be given within 20 to 30 minutes after exposure. First-aid instructions are given in TM 9-850 and FM 21-40.

(b) Garments exposed to mustard should be decontaminated. If the impermeable clothing has been exposed to vapor only, it may be decontaminated by hanging in the open air, preferably in sunlight, for several days. It may also be cleaned by steaming for 2 hours. If the impermeable clothing has been contaminated with liquid mustard, steaming for 6 to 8 hours will be required. Various kinds of steaming devices can be improvised from materials available in the field.

(2) PROCEDURE.

(a) Commence by freeing materiel of dirt through the use of sticks, rags, etc., which must be burned or buried immediately after this operation.

(b) If the surface of the materiel is coated with grease or heavy oil, this grease or oil should be removed before decontamination is begun. SOLVENT, dry-cleaning, or other available solvents for oil should be used with rags attached to ends of sticks. Following this, decontaminate the painted surfaces of the materiel with bleaching solution made by mixing one part AGENT, decontaminating (chloride of lime) with one part water. This solution should be swabbed over all surfaces. Wash off with water thoroughly, dry all surfaces, and coat with grease or heavy oil.

(c) All unpainted metal parts and instruments exposed to mustard or lewisite must be decontaminated with a AGENT, decontaminating, noncorrosive, mixed with one part solid to fifteen parts solvent (ACETYLENE TETRACHLORIDE). If this is not available, use warm water and soap. Bleaching solution must not be used, because of its corrosive action. Instrument lenses may be cleaned only with PAPER, lens, tissue, using a small amount of ALCOHOL, ethyl. Coat all metal surfaces lightly with engine oil.

(d) In the event, a AGENT, decontaminating (chloride of lime), is not available, materiel may be temporarily cleaned with large volumes of hot water. However, mustard lying in joints or in leather or canvas webbing is not removed by this procedure and will remain a constant

source of danger until the materiel can be properly decontaminated. All mustard washed from materiel in this manner lies unchanged on the ground, necessitating that the contaminated area be plainly marked with warning signs before abandonment.

(e) The cleaning or decontaminating of materiel contaminated with lewisite will wash arsenic compounds into the soil, poisoning many water supplies in the locality for either men or animals.

(f) Leather or canvas webbing that has been contaminated should be scrubbed thoroughly with bleaching solution. In the event this treatment is insufficient, it may be necessary to burn or bury such materiel.

(g) Detailed information on decontamination is contained in FM 21-40, TM 9-850, and TC 38, 1941 Decontamination.

45. SPECIAL PRECAUTIONS FOR AUTOMOTIVE MATERIEL.

a. When vehicles have been subjected to gas attack with the engine running, the air cleaner should be serviced by removing the oil, flushing with SOLVENT, dry-cleaning, and refilling with the proper grade of oil.

b. Instrument panels should be cleaned in the same manner as outlined for instruments.

c. Contaminated seat cushions should be discarded.

d. Washing the compartments thoroughly with bleaching solution is the most that can be done in the field. When running under conditions of high temperatures, operators should constantly be on the alert for slow vaporization of the mustard or lewisite.

e. Exterior surfaces of vehicles should be decontaminated with bleaching solution. Repainting may be necessary after this operation.

MEDIUM TANKS M4 AND M4A1

PART TWO—Organization Instructions

Section X

GENERAL INFORMATION ON MAINTENANCE

Paragraph
Scope 46

46. SCOPE.

a. The scope of maintenance and repairs by the crew and other units of the using arms is determined by the ease with which the project can be accomplished, the amount of time available, the nature of the terrain, weather conditions, temperatures, concealment, shelter, proximity to hostile fire, the equipment available, and the skill of the personnel. All of these are variable and no exact system of procedure can be prescribed.

b. The definitions given below are included in order that the operation name may be correctly interpreted by those doing the work.

(1) SERVICE. Consists of cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls not requiring disassembly of a unit.

(2) REPAIR. Consists of making repairs to or replacement of a part, subassembly, or assembly that can be accomplished without completely disassembling the subassembly or assembly, and does not require heavy welding or riveting, machining, fitting, and/or alining.

(3) REPLACE. Consists of removing the part, subassembly, or assembly from the vehicle and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.

(4) REBUILD. Consists of completely reconditioning and placing in serviceable condition any unserviceable part, subassembly, or assembly of the motor vehicle including welding, riveting, machining, fitting, alining, assembling, and testing.

c. The using arm personnel is authorized to remove and reinstall an engine or transmission assembly. However, the replacement of an engine with *another* engine, or the replacement of a transmission assembly with *another* transmission assembly, *must not be done by the using arms unless authorization is received from ordnance personnel.*

d. The following are the maintenance duties for which tools and parts have been provided for using arm personnel. All other replacements and repairs are the responsibility of ordnance maintenance personnel, but may be performed by the using arm personnel, when circumstances permit, within the discretion of the pertinent ordnance officer.

GENERAL INFORMATION ON MAINTENANCE

Unit	Operation	Paragraph Reference
	ENGINE GROUP	
	WRIGHT OR CONTINENTAL WHIRLWIND R-975 EC-2 AND R-975-C1	
Engine	Remove for 100 hour check	56
Engine	Reinstall (par. 46 c)	57
Engine	Trouble shooting	55
Engine	Clean and service	(Section XV)
Exhaust manifold and mufflers	Replace	58
Governor	Replace	60
Intake pipes	Replace	59
Valve clearance	Adjust	63
Valve rocker assembly	Replace	61
Valve push rod	Replace	62
	FUEL SYSTEM	
Carburetor	Replace	72
Air cleaner	Service or replace	73
Fuel lines	Repair and replace	76
Fuel pump	Replace	70
Bypass pressure regulation valve	Replace	77
Primer pump	Replace	71
Fuel tanks	Clean or replace	69
Fuel filter	Service or replace	75
	COOLING SYSTEM	
Cooling system	Service	80
Fan cowling	Clean and tighten	80
	LUBRICATION	
Oil cooler	Replace	86
Oil temperature gage	Replace	125
Oil filter	Replace	85
Oil strainer	Clean	7
Oil pressure	Adjust	83
Oil pressure gage	Replace	125
Oil pump	Replace	84
Oil lines, external	Replace	87
Oil tank	Service and replace	87
	CLUTCH	
Clutch pedal	Adjust	91
Clutch plate	Replace	92
Clutch	Adjust, clean and service	95
	PROPELLER SHAFT	
Propeller shaft assembly	Replace	99

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Unit	Operation	Paragraph Reference
	POWER TRAIN	
Steering brake band assembly	Replace	105
Steering brake band	Adjust	105
Steering lever	Replace	105
Gear shift lever	Replace	102
Final drive assembly	Replace	106
Power train	Remove and reinstall	108
Sprockets	Replace	107
	SUSPENSION AND TRACKS	
Bogie wheel	Replace	111
Volute springs	Replace	111
Track supporting roller assembly	Replace	113
Idler wheel	Replace	113
Track	Replace, rebuild or reverse	112
Bearings and oil seals (wheel, bogie and idler)	Replace	111
	ELECTRICAL AND IGNITION SYSTEM	
Magneto	Replace	139
Magneto breaker points	Adjust	137 and 142
Ammeter	Replace	125
Voltmeter	Replace	125
Generator	Replace	118
Voltage regulator	Replace	119
Tachometer and cable	Replace	125
Starting motor	Replace	135
Starter switch (on dash)	Replace	125
Starter switch (solenoid)	Replace	122
Magneto switch	Replace	125
Battery switch	Repair or replace	117
Battery	Charge and service	116
Battery	Replace	116
Spark plugs	Replace	134
Electrical wiring and conduits	Replace and repair	146
Ignition harness assembly	Replace	133
Booster coil	Replace	146
All lights	Aline, service, or replace	131

GENERAL INFORMATION ON MAINTENANCE

Unit	Operation	Paragraph Reference
Speedometer and cable	Replace	125
Circuit breakers	Replace	121
Siren	Replace	132
	AUXILIARY GENERATOR	
Auxiliary generator	Replace	149
Magneto	Adjust	149
Air filter	Clean	149
Fuel filter	Clean	149
Spark plug	Service and replace	149
	GUN FIRING MECHANISMS AND CONTROLS	
Stabilizer	Charge with oil	150
	Service and replace major components	160–171
Turret cal. .30 machine gun	Replace	198
	HULL AND TURRET	
Bolts, nuts, and screws	Tighten	199
Insulation	Replace or repair	201
Turret hatch ring	Replace	200
Hatch covers and pistol port	Service or replace	201
Escape hatch	Service or replace	202
Traversing mechanism components (electric and hydraulic)	Replace	173–197

Section XI

TOOLS AND EQUIPMENT

Paragraph

Organization 47

47. ORGANIZATION.

a. Tank Crew Tools and Equipment. The tools and equipment ordinarily required for operations performed by the using arm (first echelon) are included as regular equipment with each Medium Tank M4 and M4A1, and are listed in section VIII and also in the chart in this paragraph.

b. Company Tools and Equipment. The tools and equipment ordinarily required for tank inspection and maintenance in the field include many items not used by the tank crew, and are not provided with each tank. They are a regular part of company equipment and materiel to be used on all Medium Tanks M4 and M4A1 in the company.

c. Regimental Tools and Equipment. A still more extensive group of regular and special tools and special equipment is provided for use of the regimental maintenance unit. They cover all requirements of first and second echelon maintenance.

d. Care of Tools and Equipment. An accurate record of all tools and equipment should be kept in order that their location and condition may be known at all times. Items becoming lost or unserviceable should be immediately replaced. All tools and equipment should be cleaned, lightly oiled, and in proper condition for further use before being returned to their location. Care must be used in fastening the tools carried on the outside of the tank, and frequent inspection and oiling is necessary to prevent corrosion.

e. Chart of Organization Special Repair Tools.

List of Equipment	Source of Supply
ADAPTER, button head to bayonet type	On vehicle, tank company set, regimental maintenance platoon set
TEE, combination, ¾-in. sq drive	On vehicle
BAG, tool	On vehicle
CAN, oil, trigger type, 1 pt	On vehicle
CABLE, towing	On vehicle, tank company set

TOOLS AND EQUIPMENT

List of Equipment	Source of Supply
COMPRESSOR, grease, portable, 25 lb, lever type, high pressure, w/hose and coupling	Tank company set, regimental maintenance platoon set
COMPRESSOR, volute spring	Tank company set, battalion crew set, regimental maintenance platoon set
CONE, bogie wheel oil retainer assembling	Tank company set, battalion crew set, regimental maintenance platoon set
CONE, rear idler oil retainer assembling, inner	Regimental maintenance platoon set
CONE, track support roller oil retainer assembling, inner	Regimental maintenance platoon set
CRANK, starting	On vehicle
DRIFT, engine clutch oil retainer, installing	Regimental maintenance platoon set
DRIFT, track and connector, removing	Tank company set, regimental maintenance platoon set
EYE-BOLT, lifting, engine compartment top plate	Tank company set, battalion crew set, regimental maintenance platoon set
EYE-BOLT, 3/4-16 NF-2, turret front plate, 75-mm rotor shield	Regimental maintenance platoon set
EYE-BOLT, 1-8 NC-2, transmission	Regimental maintenance platoon set
EYE-BOLT, 1-14, NC-2, turret and cupola	Regimental maintenance platoon set
FIXTURE, track connecting, with jack and handle, adjustable	On vehicle, tank company set, battalion crew set, regimental maintenance platoon set
FITTING, lubricating, button head type, 1/8-37 NPT, male	Tank company set, regimental maintenance platoon set
GAGE, feeler, 0.010 and 0.070	Tank company set, regimental maintenance platoon set
GUIDE, bogie wheel gudgeon assy.	Tank company set, battalion crew set, regimental maintenance platoon set
GUN, lubr. high pressure, lever type, 1 lb	On vehicle
HAMMER, machs., ball peen, 32 oz	On vehicle
HAMMER, slide bogie wheel gudgeon	Tank company set

MEDIUM TANKS M4 AND M4A1

List of Equipment	Source of Supply
HOSE, lubricating, 15-in., heavy duty, b. hd. fitting	On vehicle
LIFT, bogie	Tank company set, battalion crew set, regimental maintenance platoon set
PLATE, lifting, clutch spindle and cover assembly	Tank company set, battalion crew set, regimental maintenance platoon set
PLIERS, side cutter, 8-in. parallel jaw	On vehicle
PLIERS, combination, slip joint, 8-in.	On vehicle
PROTECTOR, bogie wheel gudgeon driving	Tank company set, battalion crew set, regimental maintenance platoon set
PULLER, gudgeon, screw type	Regimental maintenance platoon set
PULLER, idler wheel	Regimental maintenance platoon set
SCREWDRIVER, mach., extra heavy duty, 5-in. blade	On vehicle
SCREWDRIVER, valve clearance adjusting screw	Tank company set, battalion crew set, regimental maintenance platoon set
SLING, engine, universal	Regimental maintenance platoon set
SLING, power train complete	Regimental maintenance platoon set
SOCKET, wrench, single hex., $1\frac{1}{16}$-in.	Tank mechanic set
SOCKET, wrench, $1\frac{3}{16}$-in. hex., $\frac{1}{2}$-in. sq drive, extra deep	On vehicle, regimental maintenance platoon set
SOCKET, wrench, $1\frac{5}{16}$-in. hex., $\frac{1}{2}$-in. sq drive	On vehicle, tank company set, regimental maintenance platoon set
SOCKET, wrench, $\frac{7}{8}$-in. hex.	Tank mechanic set
SPREADER, suspension gudgeon clamping slot	Tank company set, battalion crew set, regimental maintenance platoon set
TIMER, engine, complete w/fan, cowl and flywheel	Regimental maintenance platoon set
TOOL, idler wheel installing	Regimental maintenance platoon set

TOOLS AND EQUIPMENT

List of Equipment	Source of Supply
TOOL, installing companion flange	Regimental maintenance platoon set
WRENCH, adjustable, single-end, 8-in.	On vehicle
WRENCH, box, starter, attaching $^{9}/_{16}$ hex., special	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, engineers, dble.-hd., $^{3}/_{8}$ x $^{7}/_{16}$-in.	On vehicle
WRENCH, engineers, dble.-hd., alloy-S., $^{1}/_{2}$ x $^{9}/_{16}$-in.	On vehicle
WRENCH, engineers, dble.-end, alloy-S., $^{5}/_{8}$ x $^{3}/_{4}$-in.	On vehicle
WRENCH, engineers, dble.-hd., alloy-S., $^{11}/_{16}$ x $^{7}/_{8}$-in.	On vehicle
WRENCH, engineers, dble.-hd., alloy-S., $^{15}/_{16}$ x 1-in.	On vehicle
WRENCH, box, flare nut, oil line fittings, $1^{3}/_{8}$-in.	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, box, generator attaching, $^{1}/_{2}$-in. hex. special	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, box, oil relief valve body check nut and cap	Regimental maintenance platoon set
WRENCH, cylinder stud nut, bridge crow foot $^{1}/_{2}$-in. hex.	Regimental maintenance platoon set
WRENCH, dble.-enc. $^{9}/_{16}$-45 deg. and 90 deg. angle	Regimental maintenance platoon set
WRENCH, engine support bolt nut, ext. long $1^{5}/_{16}$-in. hex.	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, plug $^{3}/_{4}$-in. hex. final drive, differential filler, and drain plug	On vehicle, tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, fuel pump packing gland lug	Regimental maintenance platoon set
WRENCH, track adjusting, 3-in. hex., special box	On vehicle, tank company set, battalion crew set
WRENCH, lug, exhaust elbow stud nut	Tank company set, battalion crew set, regimental maintenance platoon set

MEDIUM TANKS M4 AND M4A1

List of Equipment	Source of Supply
WRENCH, lug, intake pipe packing nut	Battalion crew set, regimental maintenance platoon set
WRENCH, lug, crankshaft thrust bearing nut	Regimental maintenance platoon set
WRENCH, magneto with gage	Tank mechanic set, regimental maintenance platoon set
WRENCH, oil pump body to crankcase stud nut	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, push rod housing adapter, complete	Regimental maintenance platoon set
Consisting of:	
EXTENSION, push rod housing adapter (1)	
HANDLE, push rod housing adapter (1)	
WRENCH, push rod housing adapter crowfoot, 1⅛-in. hex. (1)	
WRENCH, plug, 9/16-in. hex., transmission and oil tank drain plugs	Tank company set, battalion crew set
BIT SCREWDRIVER, ½-in. sq drive	On vehicle
WRENCH-SET, socket, alloy-S., ½-in. sq drive, 17 pieces complete	On vehicle
Consisting of:	
EXTENSION, 10-in. (1)	On vehicle
JOINT, universal (1)	On vehicle
SOCKET, 7/16-in. (1)	On vehicle
SOCKET, ½-in. (1)	On vehicle
SOCKET, 9/16-in. (1)	On vehicle
SOCKET, ¾-in. (1)	On vehicle
SOCKET, ⅞-in. (1)	On vehicle
SOCKET, 1-in. (1)	On vehicle
SOCKET, 1 1/16-in. (1)	On vehicle
SOCKET, 1⅛-in. (1)	On vehicle
RATCHET, reversible ½-in. sq drive	

TOOLS AND EQUIPMENT

List of Equipment	Source of Supply
WRENCH-SET, socket, special, 1-in. sq drive, extra heavy duty Consisting of: EXTENSION, 9-in., 1-in. sq (1) HANDLE, tubular, 36-in. long, 1 1/8-in. I.D., 1 7/16-in. O.D. (1) HEAD, square, 1-in., female (1) HEAD, square, 1-in., male (1) SOCKET, 2 1/4-in. (1) SOCKET, 1 7/16-in. (1) SOCKET, 2 3/8-in. (1) SOCKET, 1 1/2-in. (1) SOCKET, 2 5/8-in. (1) BAR, sliding 22-in. (1) HEAD, ratchet 1-in. (1) SOCKET, 1 13/16-in. (1)	Tank company set, battalion crew set, regimental platoon set
WRENCH, spanner, track support roller retainer	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, spanner, track support roller lock ring	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, socket, 2 3/8 hex., bogie wheel gudgeon hd. holding special	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, socket, 1 1/2 hex., extra deep suspension	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, 5/8-in. hex., volute spring plug, male	Tank company set, battalion crew set, regimental maintenance platoon set
STAND, inspection	Tank company set, regimental maintenance platoon set
STAND, transport	Regimental maintenance platoon set
COMPRESSOR, valve spring	Regimental maintenance platoon set
DISK, timing	Regimental maintenance platoon set

MEDIUM TANKS M4 AND M4A1

List of Equipment	Source of Supply
GAGE, feeler	Tank company set, regimental maintenance platoon set
GAGE, feeler, valve tappet, adjusting	Tank company set, regimental maintenance platoon set
HOLDER, top center indicator	Regimental maintenance platoon set
INDICATOR, dial	Regimental maintenance platoon set
POINTER, timing	Regimental maintenance platoon set
PULLER, valve tappet guide and fuel pump	Regimental maintenance platoon set
SLING, engine lifting	Regimental maintenance platoon set
TURNER, crankshaft	On vehicle
WRENCH, flywheel hub nut	Regimental maintenance platoon set
WRENCH, oil pressure relief valve seat plate	Tank company set, battalion crew set, regimental maintenance platoon set
WRENCH, timing	Tank company set, regimental maintenance platoon set
WRENCH, valve adjusting	Tank company set, regimental maintenance platoon set

Section XII

ORGANIZATION SPARE PARTS AND ACCESSORIES

Paragraph
Organization spare parts and accessories 48

48. ORGANIZATION SPARE PARTS AND ACCESSORIES.

a. The Medium Tanks M4 and M4A1 are equipped with a number of accessories and spare parts for the various guns carried in the tanks. These accessories and spare parts are kept in the tanks, in special clips provided, and in stowage boxes designed for the purpose. The spare parts and accessories and the quantities in which they are furnished are listed in section VIII, paragraph 40. Whenever spare parts are put into service, they should immediately be replaced, so that the original quantities will be available. Accessories which become lost or unserviceable should also be replaced immediately.

b. Spare parts for the tanks except in a few minor instances, are not carried in the tanks. When replacements are necessary, the new parts are secured by exchanging the worn or damaged parts for new ones.

MEDIUM TANKS M4 AND M4A1

Section XIII

PERIODIC INSPECTIONS

	Paragraph
General	49
50-hour inspection	50
100-hour inspection	51

49. GENERAL.

a. In addition to the daily inspections given to the tank by the crew, regular and complete inspections will be made at prescribed intervals by the company maintenance. More detailed and extensive than the inspections made by the crew, they provide a systematic and over-all check of the condition of the tank, assure the making of necessary adjustments, repairs, and replacements, and are an important part of preventive maintenance. These periodic inspections will be strictly observed as a positive means of keeping vehicle failures and major repairs and replacements at a minimum.

50. 50-HOUR INSPECTION.

a. General Instructions. At the end of every 50 hours of operation the tank will be given a complete inspection by the maintenance personnel of the tank company. Under severe or unusual operating conditions, it may be deemed necessary to make this inspection before the 50 hours have elapsed. This inspection is intended to disclose all items which need repair or replacement. There may be a number of defects disclosed by this inspection which cannot be repaired or replaced by the company maintenance personnel. After the company has performed its required lubrication and cleaning, they will do what repairs or replacements their tools and personnel training will allow. The remainder will be forwarded to higher echelons of maintenance for action. It is the company's responsibility to inform higher echelons of maintenance of repairs and replacements needed beyond their capacity as soon as possible.

b. Specific Steps in 50-Hour Inspection.

Item to Be Inspected	Possible Defect	Operation or Remedy
Inspector takes a position in front of tank.		
Towing shackles	Shackles or cotter pins missing	Replace
Tow cable bracket	Broken or missing	Replace or repair

PERIODIC INSPECTIONS

Item to Be Inspected	Possible Defect	Operation or Remedy
Final drive units	Oil level low	Refill
	Cap screws loose or missing	Tighten or replace
	Drain plugs loose	Tighten
	Oil leaks	Replace gasket
Mudguards	Torn or bent	Reweld or straighten
	Bolts loose or missing	Tighten or replace
Siren cable	Damaged	Replace or repair
Siren bracket	Broken or missing	Replace or repair
Headlights	Burned out	Replace bulb
	Lens broken	Replace
	Cannot be removed	Repair catch
	Switch defective	Check connections, replace switch
	Plug missing	Replace
	Plug doesn't fit	Have higher echelon replace or repair
Headlight bracket	Broken or bent	Repair or straighten
Cal. .30 machine gun	Protective shield missing	Replace
	Ball mount dirty and rusty	Clean and lubricate
	Barrel damaged	Report
75-mm gun	Cap screws missing or loose	Replace or tighten
	Debris or splash wedged in shield	Clean
Ventilator	Clogged with dirt	Clean
Inspector moves to right side of tank.		
Sprocket	Mounting bolts loose or missing	Tighten or replace
	Less than $\frac{1}{16}$-inch clearance between sprocket teeth and wedge bolts	Reverse sprocket or replace
	Cracked sprocket	Replace sprocket
Connectors	Cracked, broken, or bent	Replace
	Worn	Replace
Wedge nuts	Loose or damaged	Tighten all nuts or replace
Track	Loose	Tighten
	Worn	Reverse or replace
	Dead block	Replace

MEDIUM TANKS M4 AND M4A1

Item to Be Inspected	Possible Defect	Operation or Remedy
Bogie bracket	Cap screws loose or missing	Tighten, replace, or replace safety wire
Volute spring	Broken or weak	Replace
Support rollers	Grease leaks	Replace seal
	Cap screws, front and rear, loose, broken, or missing	Tighten or replace
	Spanner nut loose	Tighten
	Grease fitting or relief valve damaged	Replace
Bogie tires	Worn	Replace
	Grooved	Report
Bogie wheels	Grease leaks	Replace seal, clean, loosen, or replace relief valve
	Bogie wheel nuts loose	Lift bogie wheel and tighten
Bogie arm wear plate	Worn	Replace
Bogie arm lock nut	Loose	Tighten
Hull rivets	Loose	Report
Idler bracket rivets	Loose	Report
Hubs, idler	Grease leaks	Replace seal
Relief valves	Clogged with dirt	Clean, loosen, or replace
Grease fittings	Clogged with dirt	Clean or replace
Idler wheel	Damaged	Replace
Idler adjustment	Damaged or loose	Replace or tighten

The above items are common to both sides of the tank.
The following items are peculiar to the right side:

Axe, bar, mattock, and handle	Missing, dirty, rusty, or dull	Replace, clean, or sharpen

The following are peculiar to the left side of the tank:

Tow cable	Missing, damaged, rusty, or dirty	Clean or replace
Shovel	Missing, damaged, rusty, or dirty	Clean or replace

PERIODIC INSPECTIONS

Item to Be Inspected	Possible Defect	Operation or Remedy
Inspector moves to the rear of the tank.		
Taillights	Wiring loose or defective	Repair
	Bulbs burned out	Replace
	Lens broken	Replace
	Switch defective	Check connections, replace switch
Crank	Missing	Replace
Tow cable bracket	Broken or missing	Repair or replace
Mudguards	Bent, broken, or bolts missing or loose	Straighten, weld, replace, or tighten
Tow shackles	Shackles or cotter pins missing	Replace
Open door over engine compartment and inspect engine from top.		
Exhaust connections	Loose or missing	Tighten or replace
Priming lines	Leaks	Tighten or replace lines
	Broken lines	Replace lines
Intake pipes	Loose. Possible breaks allowing dirty air to enter engine	Tighten or repair
Ignition harness	Breaks in shielding	Solder
	Loose connections	Tighten
Starter	Loose mounting bolts	Tighten
Engine beam mounting	Rubber suspension has failed allowing engine to drop	Replace
Sponson gas valves	Loose or sticking	Repair
Ground strap	Loose or broken	Repair
Booster	Connections loose or damaged	Repair
	Leads damaged	Repair
	Poor spark	Replace
Upper fire extinguisher horns	Clogged with dirt	Clean
	Loose connections	Tighten
Breather lines	Loose or damaged	Repair or replace
Rocker box covers	Oil leaks	Tighten nuts
Junction box	Connections loose	Tighten
	Mounting loose	Tighten
Fire extinguisher line	Loose or damaged	Tighten or repair
Air intake tubes	Dirty	Clean

MEDIUM TANKS M4 AND M4A1

Item to Be Inspected	Possible Defect	Operation or Remedy
Clutch release bearings	1/8-inch clearance not present	Adjust
Gas tank valves (4)	Inoperative, loose, or sticking	Repair
Oil cooler radiators (2)	Dirty	Clean
Fuel gage line	Leaks and loose	Repair and tighten
Breather line to engine nose	Loose	Tighten
Six shroud bolts	Loose or missing	Tighten and replace
Propeller shaft	Loose bolts or damaged	Tighten, repair, or replace
	Grease leaks	Replace seal
Open rear doors and inspect engine.		
Oil filter		Drain and flush
Fuel filter		Drain and flush
Connections to fuel pump	Loose or damaged	Tighten, repair, or replace
Fuel pump mounting studs	Loose or damaged	Tighten, repair, or replace
Connections to carburetor	Loose or damaged	Tighten, repair, or replace
Connections to oil pump	Loose or damaged	Tighten, repair, or replace
Connections to oil dilution valve	Loose or damaged	Tighten, repair, or replace
Scavenge pump oil line	Loose or damaged	Tighten, repair, or replace
Tachometer shaft	Loose or damaged	Tighten, repair, or replace
Governor oil return line	Loose or damaged	Tighten, repair, or replace
Oil pressure gage line	Loose or damaged	Tighten, repair, or replace
Magneto breaker points	Dirty or burned, not making proper contact	Clean, and adjust clearance
	Loose mounting	Tighten
Main oil screen		Remove and clean
Carburetor		Remove and clean screen
		Adjust idling speed if necessary
	Elbow cracked	Replace

PERIODIC INSPECTIONS

Item to Be Inspected	Possible Defect	Operation or Remedy
Engine oil.		Change while warm
		Prime system
Engine accelerator	Engine spits or backfires	Adjust
Governor	Fails to hold engine to 2,200 revolutions per minute	Report for readjustment
	Cotter pins missing or linkage worn	Replace
Intake connections	Leaks noted while engine is running	Tighten
Accelerator boot	Damaged	Replace
Priming lines	Loose or damaged	Tighten or replace
Carburetor screen		Remove and clean
Rocker box covers	Oil leaks	Tighten
Accelerator linkage	Missing cotter pins	Replace
	Damaged rods	Replace
Oil sump screen		Remove and clean, clean sump
Inspector inspects from top of tank.		
Gas tank covers	Caps missing	Replace
	Cotter pins missing	Replace
	Locking pins bent or otherwise defective	Repair
	Chain broken	Repair
Engine compartment armor	Bolts missing	Replace
	Hinges damaged	Repair
	Locking pins work hard	Repair
Turret hatch doors	Hinges damaged	Repair
	Locks damaged	Repair
AA mount	Catch does not work	Repair
	Weak spring	Repair
Cupola	Dirty race	Clean
	Grease fittings damaged	Replace or clean
Inspector gets into turret.		
Turret hatch periscope	Spare missing	Replace
	Cloudy vision	Clean
	Broken mirror	Replace
	Broken catch	Repair, lubricate, and clean
	Damaged padding	Repair

MEDIUM TANKS M4 AND M4A1

Item to Be Inspected	Possible Defect	Operation or Remedy
Gunner's persicope	Spare missing	Replace
	Cloudy vision	Clean
	Broken mirror	Replace
	Broken catch	Repair, lubricate, and clean
	Damaged padding	Repair
Loader's periscope	Spare missing	Replace
	Cloudy vision	Clean
	Broken mirror	Replace
	Broken catch	Repair, lubricate, and clean
	Damaged padding	Repair
Ventilator	Dirty and clogged	Clean
Seats		Lubricate
	Inoperative	Repair
	Damaged covers	Repair
Turret lubricating fittings (2)	Dirty or damaged	Clean or replace
75-mm gun lubricating fittings (1)	Dirty or damaged	Clean or replace
Stabilizer piston lubricating fitting	Dirty or damaged	Clean or replace
Ammunition racks and clips	Damaged or missing	Repair or replace
Gun traveling lock	Damaged	Repair
Manual traverse	Defective gears	Replace
	Dirt or splash in race	Clean
	Handle damaged	Repair
	Loose	Tighten
Hand power traverse	Inoperative	Repair
Rapid traverse	Inoperative	Repair
Ceiling lights	Burned out	Replace bulbs
		Repair wiring
Stabilizer	Inoperative	Repair
	Hunts	Bleed, tighten all lines
Stabilizer lights	Inoperative	Repair
Firing switch, 75-mm	Inoperative	Repair
Firing switch, cal. .30	Inoperative	Repair

PERIODIC INSPECTIONS

Item to Be Inspected	Possible Defect	Operation or Remedy
Collector ring	Corrosion	Clean
	Dirt	Clean
	Water	Dry
	Worn brushes	Replace
	Poor connections	Repair
Flexible lines	Worn	Replace
	Loose	Tighten
	Damaged	Repair
Fire extinguisher	Missing	Replace
	Discharged	Recharge
	Damaged	Replace
Battery	Low water	Refill
	Switch defective	Repair
	Lines corroded	Clean
	Dirty	Clean
	Specific gravity low	Replace battery
Starting switch solenoid	Inoperative	Replace
	Connections poor	Repair
	Leads damaged	Replace
Homelite auxiliary generator		Clean air cleaner
		Clean fuel filter
		Clean and set spark plug
75-mm gun	Inoperative	Replace unit
	Breech action poor	Bore sight
	Bore dirty	Repair
	Firing mechanism defective	Clean
		Repair
		Clean gun
Cal. .30 gun	Solenoid will not fire	Replace
	Head space out	Adjust
	Bore dirty	Clean or replace barrel
	Feeding mechanism defective	Replace
	Ejector defective	Replace
	Bolt action defective	Replace
	Firing pin	Replace
Oil tank	Loose connections	Tighten
	Cap screws loose	Tighten
	Flexible lines damaged	Repair or replace
Floor drain	Defective	Repair

MEDIUM TANKS M4 AND M4A1

Item to Be Inspected	Possible Defect	Operation or Remedy
	Inspector goes to driver's seat.	
Oil pressure	Low or high	Stop engine Repair defect
Voltmeter	Inoperative	Repair connections or replace
Ammeter	Inoperative	Repair connections or replace
Fuel gage	Inoperative	Repair connections or replace
Left magneto	Engine sputters or stops	Replace spark plugs Replace magneto
Right magneto	Engine sputters or stops	Replace spark plugs Replace magneto
Steering levers	Loose or tight	Adjust
Accelerator	No free play	Adjust
	Not free	Lubricate
Hand throttle	Defective	Repair
Clutch	Not free	Lubricate
Fire extinguisher	Discharged	Charge
	Missing	Replace
	Damaged	Replace
Transmission brake	Does not lock	Adjust
Shifting lever	Inoperative	Repair
	Defective grease fittings	Replace or clean
Lights	Inoperative	Replace bulbs Replace switches Replace wiring
Siren	Inoperative	Repair or replace wiring Repair or replace switch Replace siren
Oil temperature line	Damaged or loose	Repair or tighten
Speedometer	Inoperative	Replace
Speedometer cable	Loose or damaged	Tighten or repair
Speedometer drive	Damaged grease fitting	Clean or replace
Propeller shaft	Loose nuts	Tighten or replace
	Grease leaks	Replace seal
Escape door	Inoperative	Repair

PERIODIC INSPECTIONS

Item to Be Inspected	Possible Defect	Operation or Remedy
Cal. .30 gun	Solenoid will not fire	Replace
	Head space out	Adjust
	Bore dirty	Clean or replace barrel
	Feeding mechanism defective	Replace
	Ejector defective	Replace
	Bolt action defective	Replace
	Firing pin	Replace
Transmission oil level	Low	Refill
Transmission oil breather	Dirty and damaged	Clean and repair
	Loose	Tighten
Ammunition racks	Damaged or missing	Repair or replace
Seats	Inoperative	Repair Lubricate
	Torn seats	Repair
Driver's door	Hinges damaged	Repair
	Catches inoperative	Repair
Driver's periscope	Spare missing	Replace
	Cloudy vision	Clean
	Broken mirror	Replace
	Broken catch	Repair Lubricate and clean
	Damaged padding	Repair
Assistant driver's periscope	Spare missing	Replace
	Cloudy vision	Clean
	Broken mirror	Replace
	Broken catch	Repair, lubricate and clean
	Damaged padding	Repair

51. 100-HOUR INSPECTION.

a. The 100-hour inspection should follow the procedure indicated on the 100-hour inspection report form, similar to the one shown.

100-HOUR INSPECTION
(Medium Tank, Gas Radial Engine)

NOTE: Company maintenance will prepare this in duplicate. After filling in heading and completing operations 1 and 2, both copies will be forwarded to Regt/Bn. Maintenance. Upon completion Regt/Bn. Maintenance will retain the duplicate copy and return original to company.

MEDIUM TANKS M4 AND M4A1

After this check sheet has been properly initialed and signed, the check will be posted to the service record of the tank involved and this sheet will be filed by vehicle and date separately from current records of the vehicle.

Co. ..... Armd. Regt/Bn. USA No. W— ..... Date .....

Tank Commander ..... Driver .....

Engine No. ..... Engine Hrs. ..... Miles .....

Last 100-Hour Check at ..... Hrs. Date .....

	Mech.	Crew Chief
1. All inspections of hull, track suspension, and all other parts of the tank excluding the engine will be made by the company maintenance. Any deficiencies which cannot be corrected will be listed under this paragraph.		
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2. Tank will be cleaned inside and out by company before delivering to Unit Maintenance Shop. At least two members of the crew, one the driver, will assist maintenance mechanics.		
3. Record following at 1800 rpm and normal operating temperatures.		
Oil Pressure		
(Between 50 and 80 lb)		
Oil Temperature		
(Maximum 190 deg)		
4. Remove armor over engine compartment, open doors, and remove inspection plate and inspect all oil and fuel lines for leaks (with engine running and with engine stopped).		
5. Remove engine from tank and place on inspection stand (par. 56, sec. XIV). Be certain magnetos are grounded and battery switch is open.		

PERIODIC INSPECTIONS

	Mech.	Crew Chief
6. Inspect air cleaners. Have company clean if required.		
7. Remove clutch (par. 92, sec. XVIII); cover all intake and exhaust openings and cover all fuel and oil connections on engine; then clean engine thoroughly with cleaning solvent, paying special attention to cylinder fins and baffles. NOTE: Do not put any material in lines or manifolds. Cover with rags or other material and lace secure with wire.		
8. Check clutch, fan, fan belts, flywheel bolts, and hub rivets.		
9. Clean all clutch parts and reassemble (par. 92).		
10. Replace all spark plugs. Send old plugs to Maintenance Battalion for reconditioning. Use a solid spark plug gasket 0.095-in. thick.		
11. Remove all rocker box covers.		
12. Inspect rocker arms for looseness, flat spots on rollers, and lack of lubrication.		
13. If rocker box is dry, remove push rod, blow out oil passage.		
14. Check valve clearance. Should be 0.010-in. (cold).		
15. Install rocker box covers with 7 ft lb torque, replace with new gaskets.		
16. Clean and check magneto breaker assembly for pitting and burning of breaker points.		
17. Remove generator and starter window strips; inspect brushes, terminals, and general internal appearance. Have Maintenance Battalion inspect if repairs are believed necessary.		

	Crew Mech.	Crew Chief
18. Remove the oil sump and oil inlet screens. Examine screens carefully for metal foulings. Clean thoroughly with SOLVENT, dry-cleaning, and reinstall.		
19. Drain and clean the oil sump. NOTE: Normally there will be found a very small quantity of fine particles resulting from normal wear of metal parts. However, if bronze, aluminum or steel cuttings are excessive, or pieces of broken piston rings or other large particles foreign to normal collection are present, they are a sure indication of excessive wear, scored, or broken parts. If neglected, it would cause serious damage; therefore, report same to the Unit Motor or Maintenance Officer.		
20. Examine closely the following:		
(a) Examine cowling and cowling locking devices		
(b) Inspect intake manifolds for cracks, especially where manifold enters diffuser section and cylinders; tighten *gland nuts*		
(c) Inspect exhaust manifolds for cracks, rust scales and burned out spots		
(d) Check all ignition harness for chafing, oil soaks, and damaged radio shielding		
(e) Check tightness of starter solenoid terminal fittings		
(f) Check security of all:		
(1) Starter		
(2) Magnetos		
(3) Generator		
(4) Booster		
(5) Starting solenoid		
(6) Carburetor		
(7) Cowling bolts		
(8) Engine beam brackets		
(9) Front steady rest mount		

PERIODIC INSPECTIONS

	Mech.	Crew Chief
21. Remove, drain, clean, and flush engine oil cooler, using OIL, engine, SAE 10. (Allow to drain thoroughly before replacing.) *(Check for sticking by-pass valve).*		
22. Remove, drain, clean, and flush transmission oil cooler. (Allow to drain thoroughly before replacing.) (Check for sticking bypass valve.) (Refill transmission oil cooler after installation).		
23. Drain and flush oil tank.		
24. Examine all oil and fuel line hose for worn or broken spots, flush oil lines using low-pressure air to blow through all lines to make sure they are not plugged.		
25. Dismantle and clean Cuno Oil Filter.		
26. Remove screen from fuel strainer and clean. Remove drain plug from fuel strainer.		
27. Check following for security: (a) Engine support bracket rivets (b) Engine mounting bolts and brackets (c) Rubber bushings on support bracket (d) Lower half of engine shrouding in engine compartment		
28. Clean and grease clutch release bearings, propeller shaft slip joint. (Inspect clutch release bearings for flat spots and tightness.)		
29. Clean, inspect, and oil clutch linkage in motor compartment.		
30. Reinstall engine and air cleaners in tank (Paragraph 57, section XIV). Make sure that all connections are thoroughly tightened and all conduits and lines are securely clamped in place so as to prevent chafing and kinking.		

	Mech.	Crew Chief
31. Check exhaust pipe connections for security.		
32. Check all connections between air cleaner and manifold to see that they are dust tight. Check the opening from the air cleaner to the fighting compartment to see that it is clean.		
33. Remove universal joints, clean, disassemble, inspect, and replace.		
34. Check all control linkages as follows: (a) Clutch throwout bearing clearance ⅛ in. (figs. 16 and 17, par. 7). (b) Carburetor stop clearance ⅛ in. with foot accelerator against floor (c) Check all linkages for free travel, clean, and oil. (Replace broken or missing cotter pins.)		
35. Refill oil tank		
36. Prime engine oil pump by hand, cranking while pouring oil into suction hose until one qt of oil is pulled into engine.		
37. Open gas valves and start engine; if oil pressure does not show on gage in ten seconds shut down and reprime oil pump.		
38. After engine starts with proper oil pressure, warm for ten minutes; observing all instruments and the engine for anything unusual.		
39. Adjust carburetor mixture control. Adjust idling speed for 400 rpm at carburetor. This does not infer that engine should be idled at this speed. Hand throttle will be set to idle engine at 800 rpm. This 400 rpm at carburetor allows easier gear shifting.		

PERIODIC INSPECTIONS

	Mech.	Crew Chief
40. Take tank for test run, correct any deficiencies noted.		
41. Check brake system. Levers should have 5½ in. of free play.		
42. Check engine compartment for leaks and replace armor.		
43. Check engine oil level.		

I certify that this engine is functioning properly and it is my belief that it will perform satisfactorily, mechanically, for the next 100 hours with proper care.

Remarks .....

(Inspector) (Mechanic)

(Crew Chief) (Maintenance Officer)

Section XIV

ENGINE—R-975EC-2 AND R-975-C1

	Paragraph
General description	52
Periodic inspection (50 hour)	53
Periodic inspection (100 hour)	54
Trouble shooting	55
Removal of engine	56
Installation of engine	57
Exhaust system	58
Intake pipes	59
Governor	60
Rocker arms	61
Push rods	62
Valve clearance adjustment	63
Valve springs	64
References	65

52. GENERAL DESCRIPTION (figs. 52 and 53).

a. A single row, air-cooled, radial, aviation type engine is used.

Direction of rotation (from rear or magneto end):

Crankshaft	Clockwise
Tachometer drive	Counterclockwise
Fuel pump	Counterclockwise
Starter	Counterclockwise
Generator	Counterclockwise
Magneto	Counterclockwise

Magneto:

Magneto breaker points gap (R-975EC-2 engine)	0.012 in.
Magneto breaker points gap (R-975-C1 engine)	0.008-0.010 in.
Spark plug gap, mica plugs	0.012-0.015 in.
Valve clearance (cold engine)	0.010 in.

Oil:

Engine oil pressure at operating speeds	60 lb min. to 80 lb max.
Quantity	36 qt
Temperature at inlet (max. allowable)	190 F
Temperature at inlet (desired)	140 F

Firing order (No. 1 cylinder at top cylinders numbered clockwise, from rear.) 1, 3, 5, 7, 9, 2, 4, 6, 8

ENGINE—R-975EC-2 AND R-975-C1

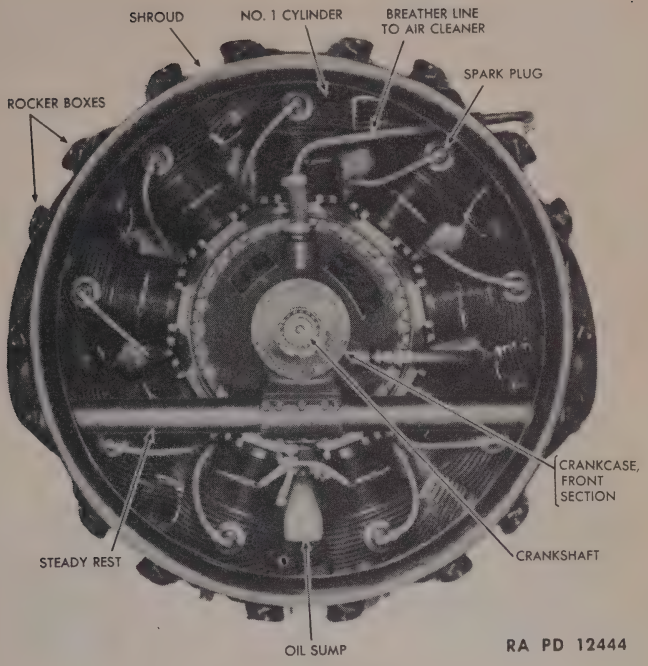

Figure 52—Front View of Engine with Flywheel Removed

Model R-975EC-2 (engines with black name plate):

Compression ratio	6.3 to 1
Min. fuel octane	91
Rated horsepower	400

Model R-975-C1 (engines with blue name plate)*:

Compression ratio	5.7 to 1
Min. fuel octane	80
Bore	5.00 in.
Stroke	5.50 in.
Displacement	973 cu. in.
Rated horsepower	380

b. Modifications for Use of 80 Octane Fuel. To simplify the fuel requirements of the Medium Tanks M4 and M4A1, all but the earliest models will come equipped with an R-975 C-1 engine bearing a blue name plate. This indicates that the engine has a 5.7 to 1 compression ratio and will operate efficiently on 80 octane fuel. Models prior to those with this engine will have a black name plate R-975EC-2 engine, and

* See paragraph 52 b.

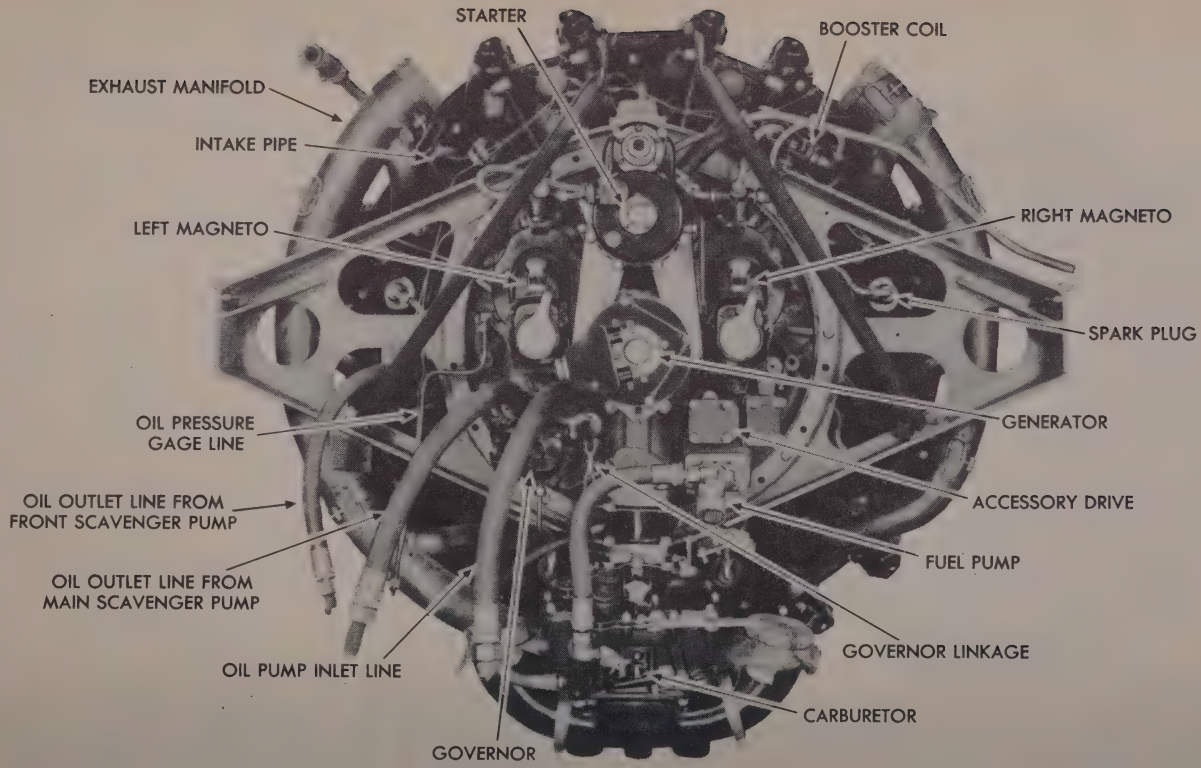

Figure 53—Rear View of Engine with Support Beam

will require 91 octane fuel. Engines in the field will be modified as quickly as possible to conform to the blue name plate engine, and will be provided with the proper name plate when the modifications have been completed. Because of resulting changes in timing requirements the magnetos on the modified engines must be changed. The magnetos timed for the blue name plate engine are identified by means of green markings.

c. In this section the flywheel end of the engine will be referred to as the "front" of the engine and the other end will be referred to as the "rear" of the engine. The terms "right" and "left" are used with reference to the engine as viewed from the rear. Horizontal and vertical positions of the engine will be referred to with respect to the position of the crankshaft. Direction of rotation is determined by viewing from the rear of the engine.

d. The two magnetos, starter, generator, governor, oil pump, and fuel pump are mounted on the accessory case at the rear of the engine (fig. 53). The carburetor is mounted on the extreme lower end of the rear section. The accessory case is attached to the rear face of the crankcase and houses the gear train that drives the various accessories, such as the magnetos, starter, generator, etc.

e. The engine is supported in the engine compartment by means of support brackets and a support beam (banjo) at the rear, and a steady rest tube and support brackets at the front.

53. PERIODIC INSPECTION (50-Hour).

a. In connection with the periodic inspections given in full in section XIII, there are a number which apply to the engine. These inspections have been grouped together for convenient reference, and should be made regularly and completely. Periodic inspection, with the proper adjustments or repairs being made immediately, is the surest way to protect the life and efficiency of the engine.

54. PERIODIC INSPECTION (100-Hour).

a. As indicated in section XIII, paragraph 51, the engine is removed from the tank every 100 hours of operation for a more complete inspection and cleaning than is possible while it is in the tank. It is important at this time to inspect all lines for signs of leaks *before* the engine has been cleaned, since the evidence of leakage may be entirely removed by cleaning. Spark plugs should not be removed and replaced until *after* the engine has been cleaned. Old plugs should be replaced with dummy plugs to keep all dirt out of the interior of the engine until the new plugs

can be installed. Particular care should be taken in disconnecting and connecting all lines and leads, to avoid the necessity of replacement because of damage directly due to the removal or installation of the engine.

55. TROUBLE SHOOTING.

a. This paragraph is devoted to a discussion of the most common engine troubles and their likely causes. Its purpose is to minimize, in so far as possible, the time wasted in locating the source of a given trouble.

b. **General Trouble Shooting Procedure.** The best method of trouble shooting is to take the possible causes and eliminate them, one by one, starting with the most probable cause. The first step is to determine in what system the trouble exists; whether it is in the fuel system, the electrical system or the lubrication system. Then that particular system should be checked beginning at the source. Thus, in case of electrical system trouble in the battery circuit, the battery would be the first point of check. Similarly the fuel supply would be checked first if the trouble were localized in the fuel system.

c. **Localizing Troubles.** An attempt should be made early to further localize and isolate troubles by classifying them as general troubles and local troubles. A general trouble is one affecting all cylinders alike, in which case the mechanic will know that the difficulty must be in some accessory that will affect all cylinders. For example, if all cylinders fail to fire, it is likely that the magnetos, rather than all nine spark plugs, are at fault. However, if only one cylinder is missing it can be assumed that the magnetos are not at fault, since, if they will fire eight cylinders, they should fire the ninth. So the trouble would be localized to the spark plugs or spark plug leads of that particular cylinder.

d. **Reporting Major Troubles.** While the following material on engine troubles and their remedies will help to locate and correct many engine conditions which may arise in the field, it should be emphasized that the engine *is not to be experimented on.* If the source of the trouble cannot be readily located, or if there is any doubt in the mind of the mechanic as to the correct remedy, the trouble should be immediately reported to the proper authority.

e. **Failure of an Engine to Start.** If the engine fails to start after repeated attempts, the source of trouble can be due to fuel system troubles, ignition system troubles, mechanical troubles, or a combination of them. If the priming pump is delivering a charge (which can be determined by feel), the priming system can be used to determine if the ignition system is operative. With the engine receiving a priming charge,

there should be firing in a few cylinders until the charge is exhausted. If there is *no* evidence of firing in any cylinder, it can be assumed that the ignition system is at fault. Coughing or sputtering, with failure to start, indicates failure in the fuel system. Probable causes of starting failures, and the steps to take to correct them are listed below.

(1) FUEL SYSTEM TROUBLES.

Lack of fuel.	Check fuel supply. Check position and operation of shut-off valves. Check fuel lines and operation of fuel pump. Remove, inspect, and clean carburetor fuel strainer.
Incorrect throttle opening.	Check position of hand throttle. It should not be more than one-tenth open while attempting to start engine.
Water in carburetor.	Remove right and left float chamber drain plugs and fuel strainer. Drain off fuel.
Over priming.	Turn engine over with starting motor, with ignition switch "OFF" and throttle at "FULL OPEN" position.

(2) IGNITION SYSTEM TROUBLES.

Inoperative booster coil.	Check booster output by holding lead 3/8 inch from ground. Check leads, wiring, and switch.
Loose, grounded or broken ignition wiring.	Inspect all connections. Test lines for breaks or grounds with test light (par. 146 b).
Inoperative spark plugs.	Replace plugs (par. 134 b).
Faulty magneto breaker points.	Check for presence of oil, pitting or dirt. Check gap and adjust to 0.012 inch (par. 137 or 142).

f. Engine Starts but Stops. It may be assumed that if the ignition system will fire the engine for a minute or so, it should operate it indefinitely. If the engine stops with sputtering and backfiring, the trouble probably lies in the carburetor or fuel system. If the engine stops abruptly, as it would when switching from a good to a defective magneto, it is likely that the fault is in the ignition system.

g. Engine Runs but Does Not Stop. Proper stopping of the engine is done by operating the solenoid fuel cut-off valve by means of the toggle switch on the instrument panel. If the engine fails to stop with the toggle switch held in the "OFF" position, the fault must lie in the solenoid operation or the linkage. If the solenoid is inoperative, the fault is either in the wiring to the instrument panel, or within the solenoid itself. Loose linkage will allow the solenoid to operate without affecting the valve. It should be tightened sufficiently to correct the condition, but not enough to interfere with the free return of the valve to the closed position.

h. Low Power and Uneven Running. If the engine runs unevenly, it should be determined whether it does so on one or both magnetoes. If it runs unevenly on both magnetos, a system other than ignition is probably at fault. If the irregularity occurs on only one magneto, that magneto or its attached wires and spark plugs must be the cause.

(1) FUEL SYSTEM TROUBLES.

Mixture too rich.	Evidence—rolling action of engine, black smoke or raw flame at exhaust tail pipes. Check setting of mixture control (par. 72 **c**). Check fuel pressure at carburetor end of oil dilution line, using low pressure gage. Fuel bypass regulator valve should be adjusted by the proper echelon to give pressure of 3¼ pound (par. 77 **d**).
Mixture too lean.	Evidence—uneven running, overheating, backfiring and detonation. Check setting of mixture control. Check fuel pressure. Check all intake pipe connections for leaks. Check intake pipes and carburetor elbow for cracks. Check fuel cut-off linkage for bent rod, too short adjustment or any other condition which would allow the fuel cut-off valve to remain partially open.
Improper fuel.	Drain tanks and refill with proper grade of fuel.

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Clogged fuel strainer.	Evidence—same as lean mixture or running out of fuel. Remove and clean strainer.
Clogged or restricted fuel lines.	Evidence—same as lean mixture or running out of fuel. May be evident only when engine is under full load. Check lines for kinks or restrictions. If necessary, remove and blow out lines.
Faulty carburetor.	If carburetor leaks or is cracked, it should be replaced immediately (par. 72 **c**).
Incorrect governor setting.	Check only. If butterfly valve, as indicated by control arm on throttle box, closes before engine reaches prescribed maximum speed, report condition for correction.
(2) IGNITION SYSTEM TROUBLES.	
Faulty magneto.	Evidence—stopping or abnormal drop in revolutions per minute, when switching from one magneto to the other. Check breaker points (par. 137 or 142). Check circuit to magneto switch by removing ground wires at magneto. Check distributor blocks for proper seating. Loose covers may allow blocks to jar out of place. Check secondary and spark plug lead by disconnecting lead from plug and holding it ¼ inch from a positive ground while engine is running. If spark is evident, trouble is in plugs. If no spark is delivered, remove distributor blocks and check secondary by holding a grounded wire about ⅛ inch from the distributor segments while rotating the engine. Spark

	indicates secondary correction and that fault is in wiring harness. Because of the inaccessibility of the front bank of spark plugs, the output of right magneto is checked at the distributor segments only.
Faulty spark plugs.	To determine whether it is a front or rear plug, switch from one magneto to the other. Locate the faulty plug by running engine at not less than 1,800 revolutions per minute on the faulty bank long enough for the stack on the inoperative cylinder to cool (about one minute). With engine at normal operating temperature, locate cool stack by putting drops of oil on stacks and noting the stack on which the oil fails to disappear. NOTE: While it may sometimes be necessary to replace individual spark plugs, it is recommended that all plugs be replaced when spark plug difficulty is encountered.
Faulty ignition wiring.	Remove and check spark plug leads for fraying, breaks, saturation with oil, and condition at terminals. Check leads from distributor blocks. Check ignition harness conduit for severe dents which might ground wires.
(3) MECHANICAL TROUBLES.	
Faulty valve and valve operating mechanism.	Check valve clearance (par. 63). Check valve springs and washers (par. 64). Check condition of rocker arms and push rods (pars. 61 and 62). Check valve for sticking.

Loss of compression.	Check valves as above. Remove rear bank of spark plugs and check compression of each cylinder while turning engine over with starting motor. Report condition to proper authority.
(4) ENGINE OVERHEATING.	Check for lean fuel mixture (par. 55 **h** (1)). Check valve condition (par. 55 **h** (3)). Check grade of fuel. Check efficiency of oil cooler. Check grade of oil. Check engine and engine compartment for presence of dirt, particularly around lower cylinders. Check all air passages for obstructions.

i. Loss of Oil Pressure.

Insufficient oil supply.	Check oil level.
Wrong grade of oil.	Drain oil tank and refill with prescribed grade of oil.
Faulty oil pump operation.	Check all oil line connections for air leaks. Also inspect connection at finger strainer in oil pump where thermal bulb from oil temperature gage line is installed. Disconnect oil inlet line at "Y" connection, and prime pump (fig. 81) with engine being turned over by starter. Oil will not be drawn into system unless pump is operating properly. Remove oil pressure relief assembly and check seat of the ball check valve for sticking or improper seating. CAUTION: Be extremely careful to keep all dirt from the oil pressure relief assembly when it is removed. The presence of even a minute particle of dust will throw the oil pressure off.

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Dirty sump screen.	Remove sump screen and inspect for dirt, particles of metal and other matter likely to clog the screen. NOTE: Presence of metal indicates worn bearings, and this condition should be reported to the proper authority. Check the oil filter for presence of metal particles. If any are found, report the condition to the proper authority.
Sticking oil dilution valve.	Check proper operation of valve by disconnecting the fuel line running from the dilution valve to the "Y" connection in the oil inlet line and operate switch on instrument panel. This will show if valve is completely closed when the switch is in the "OFF" position.
Excessive amount of foam in oil system.	EXCESSIVE foam in the oil system can be detected by removing the oil tank filler pipe cap while the engine is running. Presence is probably due to water accumulating in tank when flushed. Drain and clean tank and refill with clean oil.
Excessive bearing clearances.	Indicated by presence of metal particles in sump strainer and on the magnetic sump drain plug; also found on old engines. Report condition to proper authority.
High oil temperatures.	Indicated by temperature gage (par. 55 **h** (4)).

Cold-thickened oil.	Oil pressure drops when engine speed is increased beyond warm-up speed, due to inability of pump to draw thick oil through lines fast enough. Drop back to warm-up speed until oil reaches higher temperature. See paragraph 12 for special cold weather starting and operating precautions.
Fluctuating oil pressures.	Watch gage for any sudden drop in oil pressure without change in engine speed. NOTE: Oil pressures will normally vary over a considerable range due to changes in engine speed and oil temperature.

j. High Oil Consumption.

Faulty oil.	Check for proper grade of oil. Check for oil dilution and inspect operation of oil dilution valve (par. 55 i). Check for dirt and sludge by draining filter.
Insufficient oil supply.	Check oil level in oil tank.
Excessive oil temperature.	See paragraph 55 h (4).
Improper operation of filter.	Check to see that "out" side of filter is connected to return line to oil tank. Turn handle for evidence of clogged filter (par. 85 a).
Clogged sump strainer.	Remove drain plug and strainer from sump.
Improperly adjusted rocker arm adjusting screw.	See paragraph 63 b (3).
Worn piston rings or cylinders.	Check each cylinder for compression after checking proper valve operation. Report condition to proper authority.

56. REMOVAL OF ENGINE.

a. Equipment.

CHAIN
CLOTH, for openings
DRIFT
EXTENSIONS, pipe, for steady rest tube
EXTENSIONS, long (2)
HAMMER
HANDLE, sliding "T"
JACK, hydraulic
PLIERS
SCREWDRIVER
SOCKET, ratchet handle, 3/4-in.
SOCKET, long, 1 1/4-in. (2)
STAND, engine
WIRE, lacing
WRECKER
WRENCH, open-end, 1 1/32-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in. (2)
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 11/16-in.
WRENCH, open-end, 7/8-in.
WRENCH, open-end, 15/16-in. (2)
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/8-in.
WRENCH, open-end, 1 1/4-in.
WRENCH, open-end, 1 3/8-in.

b. Procedure. NOTE: The engine will have to be removed for the 100-hour inspection and for repair or replacement of any parts or assemblies which are inaccessible when the engine is in the tank.

(1) PRELIMINARY STEPS.
SCREWDRIVER

Open the main battery switches. Close the four inside fuel shut-off valves. Close the two outside fuel shut-off valves and remove the handles (screwdriver).

(2) REMOVING THE REAR SECTION OF ENGINE COMPARTMENT TOP PLATE (figs. 54 and 55).

CHAIN
DRIFT
HAMMER
PLIERS
WRECKER or HOIST
WRENCH, open-end, 15/16-in. (2)

(a) Remove the 3 cap screws that hold the rear of the plate in place (two 15/16-in. open-end wrenches). In order to place wrench on the nuts that hold the 2 outside cap screws it will be necessary to remove the covers of the 2 grouser boxes.

(b) Remove the cotter pins (pliers) from the hinge pins at the front edge of the plate and remove the pins.

(c) Hook a chain around the middle of the plate and lift off the plate with a wrecker (fig. 55).

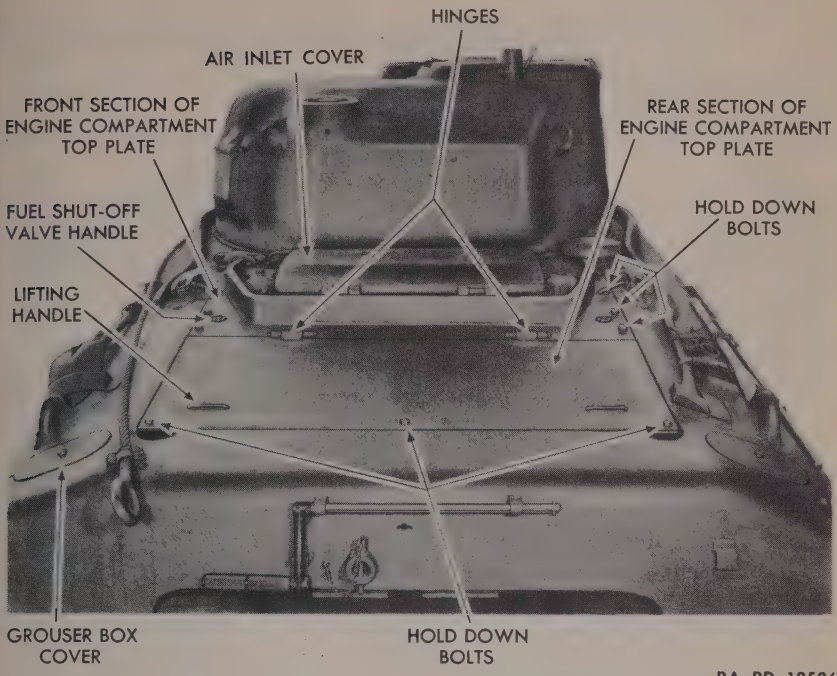

Figure 54—Engine Compartment Top Plate Before Removal

(3) Removing Front Section of Engine Compartment Top Plate (fig. 56).

CHAIN
WRECKER or HOIST
WRENCH, open-end, 9/16-in.
(2)
WRENCH, open-end, 15/16-in.
WRENCH, open-end, 1 1/8-in.

(a) Remove the 12 cap screws (8 with 1 1/8-in. open-end wrench, 4 with 15/16-in. open-end wrench) that hold the top plate to the hull.

(b) Remove the 6 bolts (two 9/16-in. open-end wrenches) that hold the upper half of the engine compartment shroud to the baffle plate on the top plate.

(c) Pass a chain under the air inlet cover and lift the plate off with a wrecker (fig. 56).

(4) Removing Muffler Assembly (fig. 57).

CLOTH
SCREWDRIVER
WIRE, binding
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
(2)

(a) Disconnect the exhaust stacks at No. 9 and No. 1 cylinders by

Figure 55—Removing Rear Section of Engine Compartment Top Plate

unsnapping the connector bands, and disconnect the exhaust manifold elbows from the main exhaust manifold rings by unsnapping the connector bands.

(b) Remove the bolt (two $^{9}/_{16}$-in. open-end wrenches) that holds the muffler support beam to the top of the engine support beam.

(c) Remove the 2 bolts ($^{1}/_{2}$- and $^{9}/_{16}$-in. open-end wrenches) that hold the 2 muffler support rods to the muffler support beam. The muffler assembly can now be lifted forward and up through the top of the engine compartment. Cover all exhaust openings on the engine with cloth and bind into place with wire.

(5) REMOVING THE UPPER HALF OF ENGINE COMPARTMENT SHROUD (fig. 58).

SCREWDRIVER
WRENCH, open-end, $^{7}/_{16}$-in.
WRENCH, open-end, $1\,^{3}/_{8}$-in.

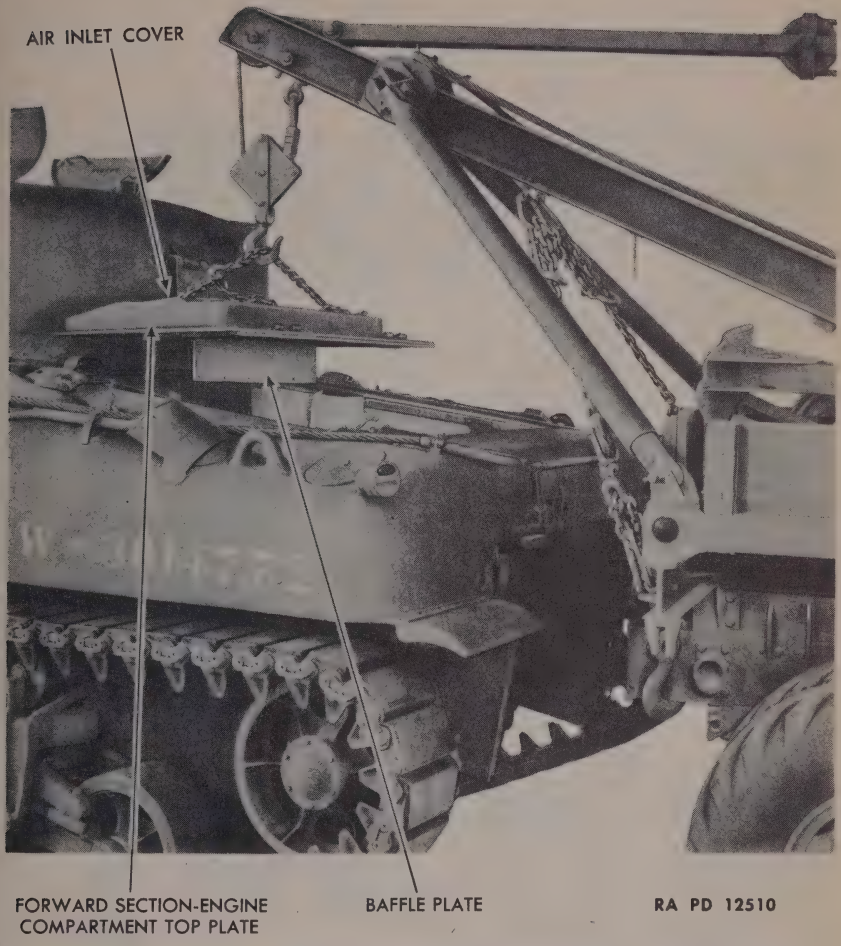

Figure 56—Removing Front Section of Engine Compartment Top Plate

(a) Remove upper air intake tubes by disconnecting the hose at the top of the air cleaner (screwdriver), then lift the tubes up and pull them out of the ports in the upper half of the engine compartment shroud.

(b) Disconnect the main fire extinguisher line (1 3/8-in. open-end wrench) at the bulkhead. Then disconnect the 2 engine compartment fire extinguisher lines just beyond the fan compartment fire extinguisher horns.

(c) Loosen the clamp that holds the auxiliary generator exhaust pipe (7/16-in. open-end wrench) and pull the exhaust pipe out of the shroud.

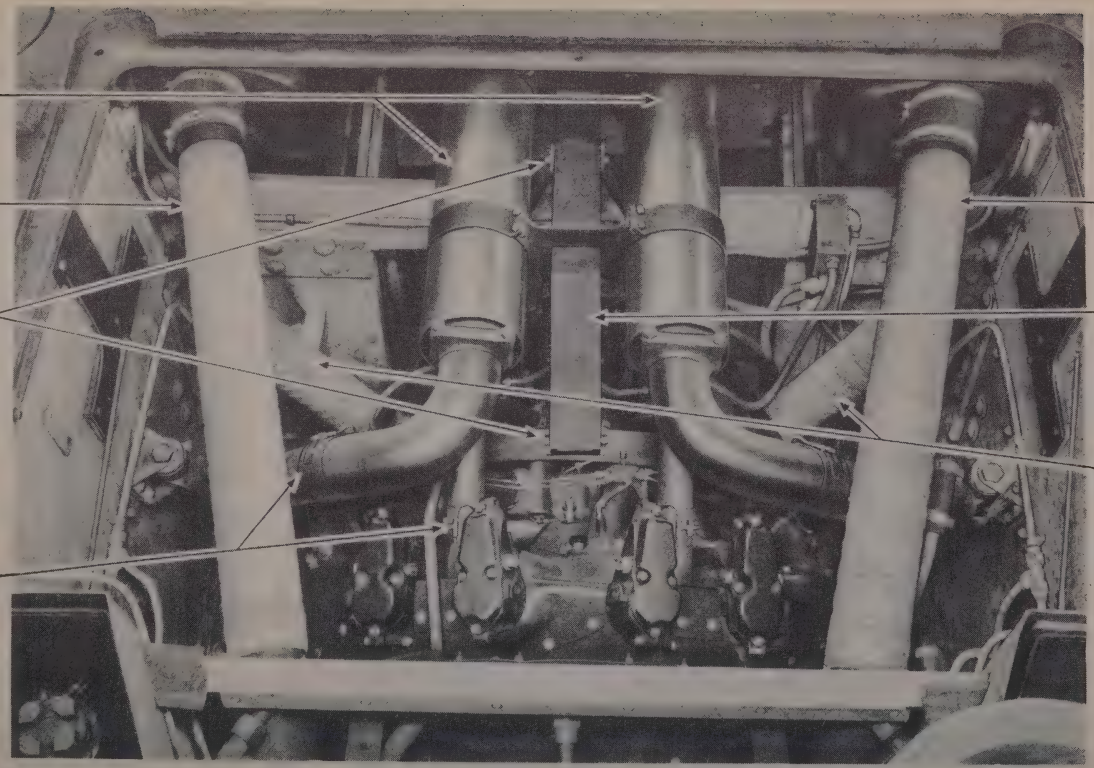

Figure 57—Engine Compartment with Top Plates Removed

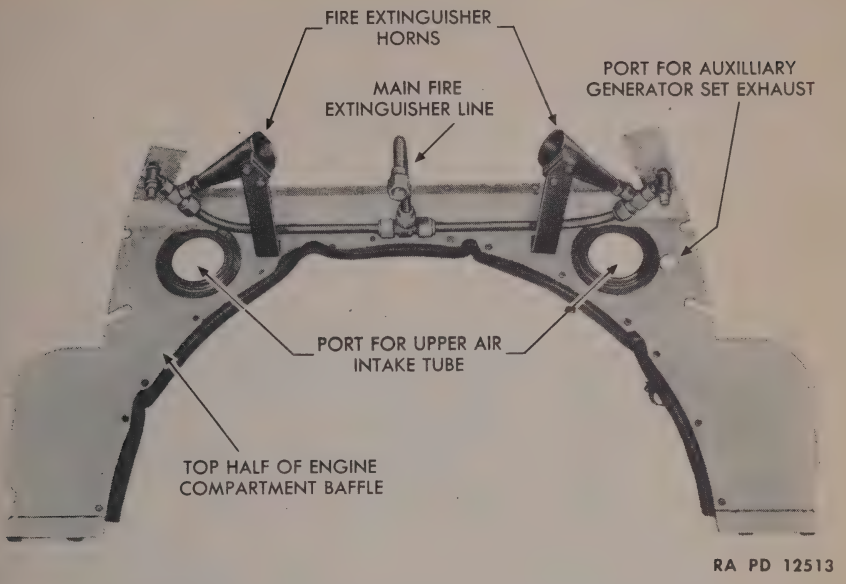
FIRE EXTINGUISHER HORNS
MAIN FIRE EXTINGUISHER LINE
PORT FOR AUXILLIARY GENERATOR SET EXHAUST
PORT FOR UPPER AIR INTAKE TUBE
TOP HALF OF ENGINE COMPARTMENT BAFFLE
RA PD 12513

Figure 58—Upper Half of Engine Compartment Shroud

(d) Remove the upper half of the shroud by lifting it up and to the rear, to clear the fuel gage and fire extinguisher lines.

(6) Removing Lower Air Intake Tubes (fig. 59).

CLOTH
SCREWDRIVER
WIRE, binding

(a) If the engine has a front breather connection, disconnect the breather pipe from the left air intake at the flexible connection (screwdriver) just above the engine support beam (fig. 59).

(b) Disconnect the flexible hoses at the air cleaners (screwdriver) and the bellows type connections at the carburetor air horns (screwdriver) and remove tubes. Immediately cover carburetor air horns with cloth, wired into place or held by means of connector clips.

(7) Remove Electrical Connections (fig. 59).

PLIERS
SCREWDRIVER
WRENCH, open-end, $1\frac{1}{32}$-in.
WRENCH, open-end, $\frac{3}{8}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.

(a) Remove shield (screwdriver), disconnect wires ($\frac{3}{8}$-in. open-end wrench), and remove conduit (pliers) from the generator.

(b) Remove shield (screwdriver), disconnect conduit (pliers), and disconnect and remove starter cable at starter.

(c) Remove cover from terminal box (screwdriver—fig. 59).

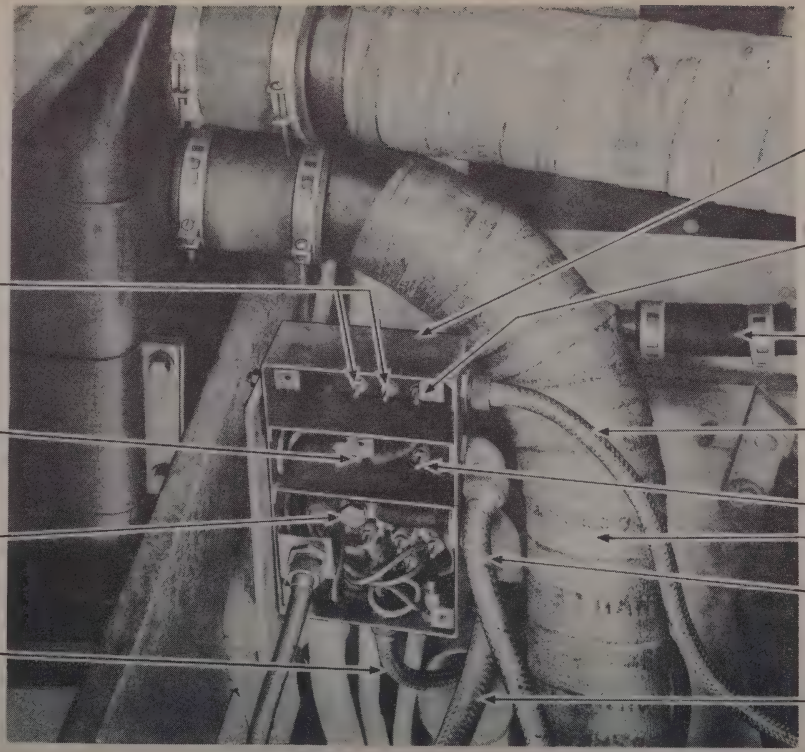
TERMINAL BOX
BOOSTER PRIMARY WIRE POST
MAGNETO GROUND WIRE POSTS
ENGINE FRONT BREATHER CONNECTION
A + POST
MAGNETO GROUNDS AND BOOSTER PRIMIARY CONDUIT
F + POST
STARTER CABLE POST
LOWER AIR INTAKE TUBE
A+ AND F+ WIRES CONDUIT
OIL DILUTION VALVE AND FUEL CUT-OFF SOLENOID LEADS CONDUIT
STARTER CABLE CONDUIT
RA PD 51355

Figure 59—Engine Compartment Terminal Box with Cover Removed

(d) Remove both magneto ground wires and the booster primary wire ($1\frac{1}{32}$-in. open-end wrench), tagging each post and wire as the disconnection is made to assure correct installation.

(e) Disconnect conduit at terminal box (pliers) and pull ground wires and booster wire out of terminal box. Immediately ground the magneto ground wires to prevent any possibility of the engine starting.

(8) Removing Fuel Cut-Off Solenoid and Solenoid-Operated Oil Dilution Valve (fig. 12).

WRENCH, open-end, $\frac{5}{8}$-in. PLIERS
WRENCH, open-end, $\frac{7}{16}$-in.
(2)

(a) Remove the cotter pin (pliers) from the clevis pin in the fuel cut-off linkage, and remove the clevis pin.

(b) Remove the 3 bolts (two $\frac{7}{16}$-in. open-end wrenches) that hold the fuel cut-off solenoid to the bracket on the engine support beam and remove the solenoid, allowing the cable to pass under the carburetor.

(c) Loosen the cable clip on the left lower side of the engine support beam (two $\frac{7}{16}$-in. open-end wrenches) and release the cable.

(d) With engines having an oil dilution valve, disconnect the fuel line from the carburetor to the oil dilution valve at the valve ($\frac{5}{8}$-in. open-end wrench).

(e) Remove the 2 bolts that hold the solenoid valve to the bracket on the engine support beam (two $\frac{7}{16}$-in. open-end wrenches) and remove the valve. Tie both the fuel cut-off solenoid and the oil dilution valve solenoid up out of the way.

(9) Removing Oil Temperature Gage Line and Tachometer Drive Cable (fig. 12).

WRENCH, open-end, $\frac{5}{8}$-in.

(a) Inspect oil temperature gage connection (fig. 12) for oil leaks before removing. Loosen retaining nut ($\frac{5}{8}$-in. open-end wrench) and remove oil temperature gage bulb from oil pump finger strainer. Plug opening.

(b) Remove tachometer drive cable (fig. 12) by unscrewing knurled nut. Tie both the oil temperature gage line and the tachometer cable up out of the way.

(10) Removing Inspection Plate and Disconnecting Accelerator Linkage.

JACK, hydraulic WRENCH, socket, $\frac{3}{4}$-in., with
PLIERS ratchet handle

(a) Remove locking wire from the cap screws that hold the inspection plate to the engine compartment floor (pliers). Remove the cap screws ($\frac{3}{4}$-in. socket wrench with ratchet handle). While removing the

last screws, support the plate with a jacket. Then, lower the plate and remove from beneath the tank.

(b) Working from beneath tank, remove cotter pin (pliers) from accelerator rod clevis pin and remove clevis pin, disconnecting the linkage.

(11) DISCONNECTING OIL LINES (fig. 60).

CLOTH
SCREWDRIVER
WIRE, binding
WRENCH, open-end, 1-in.
WRENCH, open-end, 1⅜-in.

(a) Inspect all oil line connections before disconnecting (fig. 60). Disconnect the oil pump inlet main and scavenger outlet lines (1⅜-in. open-end wrench) at the lower end of each hose. To avoid the necessity of priming the oil pump when reinstalling the engine, tie up the oil inlet line to the generator, thus keeping the oil from draining out. Be sure to loosen the right part of the coupling (the large lower nut). Attempting to turn the 2 upper hexes may sheer the hose.

(b) Disconnect the front section scavenger line at the "Y" connection with the oil outlet line (1-in. open-end wrench). As soon as oil has drained out of lines, cover the ends with cloth and wire into place. CAUTION: When making disconnections at "Y" fittings, care must be taken not to injure one connection while disconnecting the other line.

(12) DISCONNECTING FUEL LINES (fig. 60).

CLOTH
WIRE
WRENCH, open-end, ⅞-in.

(a) Inspect all fuel connections for leaks before disconnecting. Disconnect fuel inlet line at fuel pump (⅞-in. open-end wrench) (fig. 60).

(b) Disconnect fuel bypass line at the three-way elbow at the carburetor. Cover all fuel line openings with cloth and wire into place.

(13) DISCONNECTING OIL PRESSURE GAGE LINE AND PRIMER DISTRIBUTOR LINE.

WRENCH, open-end, ⅝-in.
WRENCH, open-end, 7/16-in.

Disconnect the oil pressure gage line (⅝-in. open-end wrench) and the primer distributor line (7/16-in. open-end wrench) at the disconnection points under the left side of the engine support beam. Cover both lines with cloth, secured with wire.

(14) DISCONNECTIONS AT FRONT OF ENGINE (fig. 44).

SCREWDRIVER
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 1-in.

(a) If there is a breather line from the oil expansion tank to the

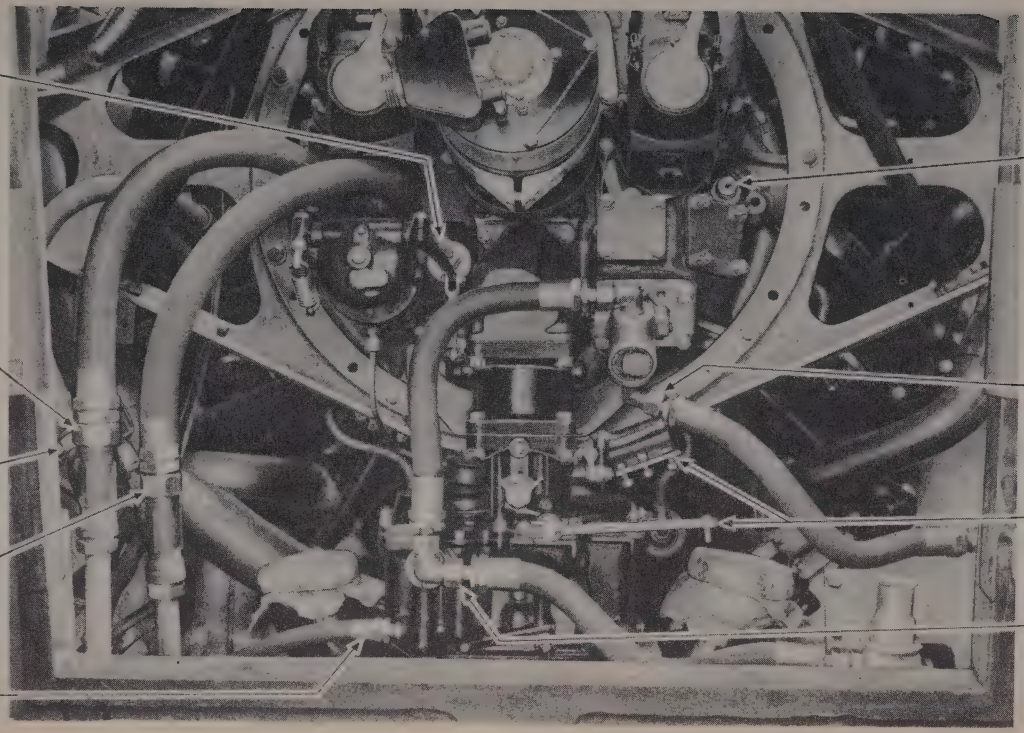
OIL TEMPERATURE GAGE BULB REMOVED
TACHOMETER CABLE REMOVED
MAIN SCAVENGER OUTLET CONNECTION
FUEL PUMP INLET LINE CONNECTION
FRONT SCAVENGER OUTLET CONNECTION
FUEL CUT-OFF SOLENOID REMOVED
MAIN OIL PUMP INLET CONNECTION
CARBURETOR BY-PASS LINE CONNECTION
FUEL LINE TO OIL DILUTION VALVE
RA PD 12486

Figure 60—Fuel and Oil Lines to Be Disconnected Before Removing Engine

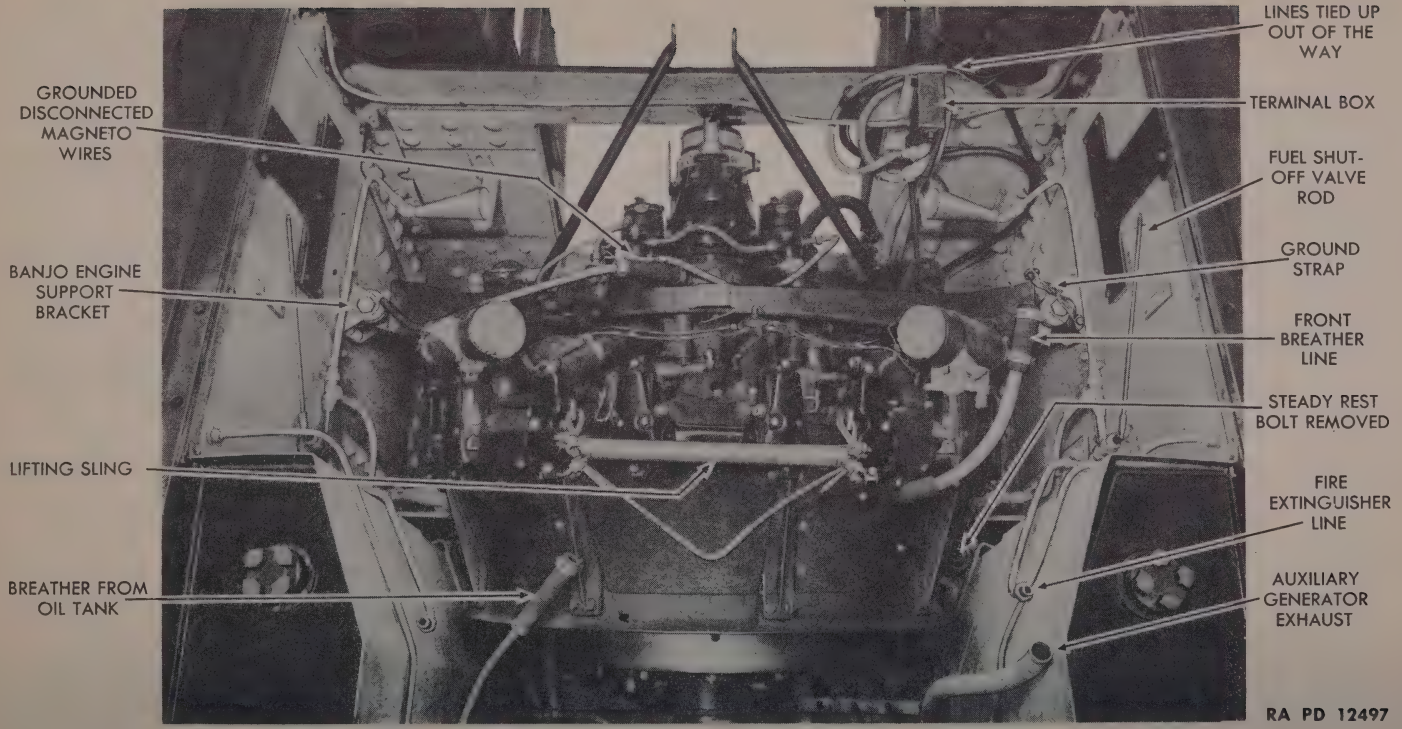

Figure 61—Disconnected Engine (with Lifting Sling Attached) Ready for Removal

engine, disconnect the breather line at the expansion tank (1-in. open-end wrench) (fig. 44).

(b) Disconnect the breather hose connection at the top of the engine (screwdriver). Pull breather line back through the bulkhead into the fighting compartment as far as possible, to get it out of the way.

(c) Remove the 8 companion flange bolts (two $^{9}/_{16}$-in. open-end wrenches) which hold clutch companion flange to universal joint flange. NOTE: The lower bolts are removed from beneath the tank through the inspection plate.

(15) FREEING THE ENGINE (fig. 59).

EXTENSIONS, long (2)
HANDLE, sliding "T"
PLIERS
SOCKET, 1¼-in.
WRENCH, open-end, $^{9}/_{16}$-in. (2)
WRENCH, open-end, 1¼-in.

(a) Remove the front steady rest bolts that hold the steady rest adapters to the steady rest brackets. This will require 2 men, the man underneath holding the bolt (1¼-in. open-end wrench) while the man above, with a 1¼-in. socket, 2 long extensions and "T" handle, turns the nut.

(*b*) Remove the bolt that holds the ground strap to the engine support beam (two $^{9}/_{16}$-in. open-end wrenches).

(c) Remove the cotter pins (pliers) from the nuts on the engine support beam holding bolts. Then remove the nuts from the 8 bolts (4 on each side) that hold the support beam to the support brackets.

(16) ATTACHING LIFTING SLING TO ENGINE (figs. 62 and 63).

PLIERS
WRENCH, open-end, $^{9}/_{16}$-in.
WRENCH, open-end, $^{11}/_{16}$-in.

(a) With pliers, remove the cotter pins from the rocker arm shaft nuts on the No. 2 intake and the No. 9 exhaust rocker arm shafts. Then, while holding the shafts with a $^{9}/_{16}$-in. open-end wrench, remove the nuts ($^{11}/_{16}$-in. open-end wrench).

(*b*) Install the lifting sling straps on the shafts (figs. 62 and 63) and replace and tighten the nuts. Install a safety chain from the center of the rear engine support beam to the clutch spring housing hub (fig. 63). NOTE: it may be necessary to disconnect one of the priming lines to prevent its being damaged by the chain.

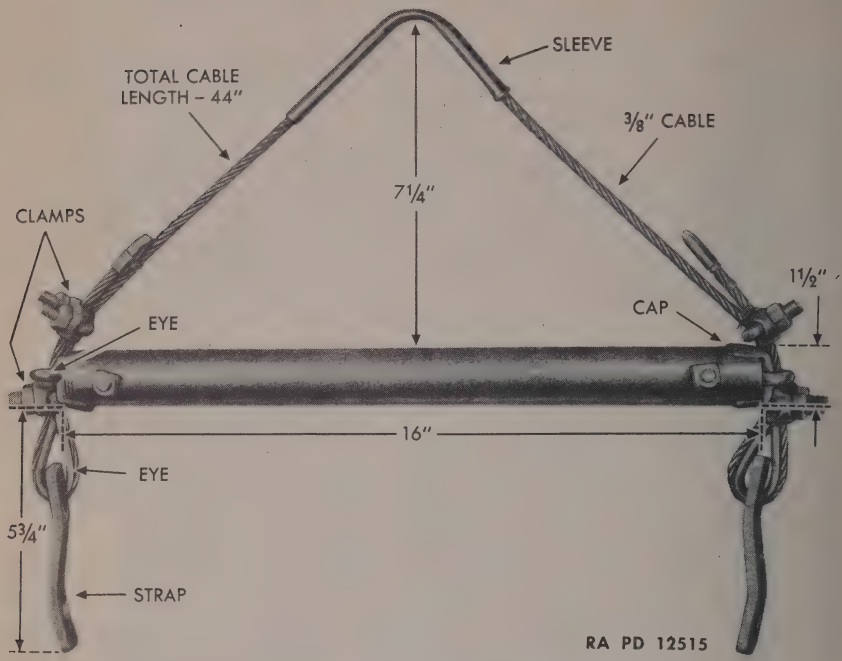

Figure 62—Detail of Engine Lifting Sling

(17) LIFTING OUT ENGINE (figs. 63 and 64).

STAND, engine
WRECKER or hoist
WRENCH, open-end, 1¼-in.
WRENCH, socket, 1¼-in.

In removing the engine with a wrecker, back wrecker up to the tank and lower boom sufficiently to lift engine vertically until it is partially out of tank (fig. 63). As soon as the weight of the engine is taken by the hoist, remove the 8 bolts securing the engine support beam to support brackets. *Extreme care must be taken to see that no part of the engine catches on any projection in the engine compartment.* Rocking the engine carefully will release the flange from the propeller shaft. In order to lift the engine high enough to clear the back of the hull, the boom of the wrecker can be raised. Have 2 men on rear of tank to hold engine away from hull. It may be necessary to turn the engine slightly to keep it clear of the hull when lifting it the balance of the distance (fig. 64). Remove the steady rest adapters. When the engine is clear of the hull, pull the wrecker ahead and lower the engine onto a suitable engine stand, putting pipe extensions into steady rest tube if needed and secure properly. Remove safety chain and lifting sling.

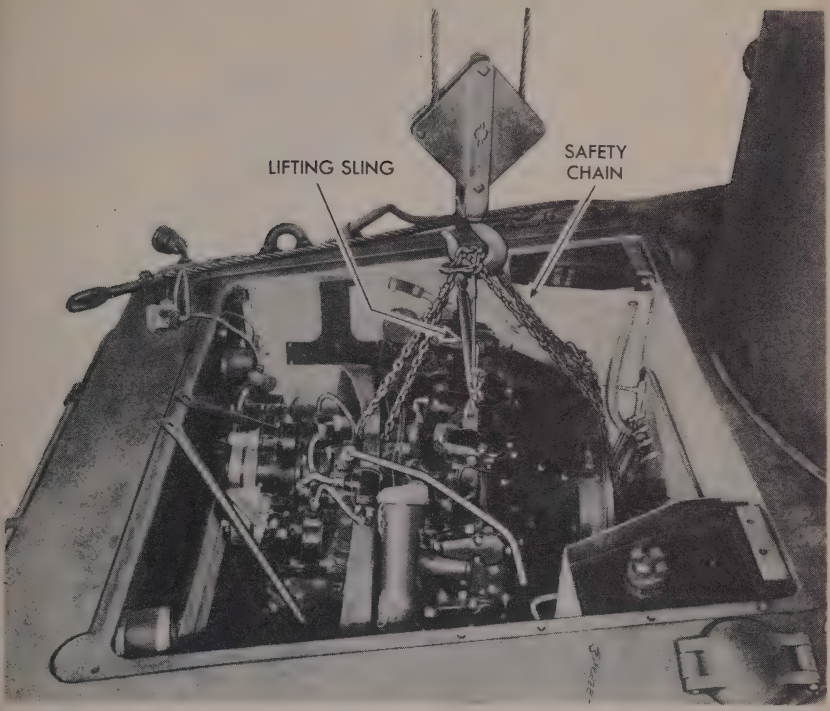

Figure 63—Engine Partially Lifted from Tank

57. INSTALLATION OF ENGINE.

a. Equipment.

CHAIN
DRIFT
EXTENSIONS, long (2)
HAMMER
HANDLE, sliding "t"
JACK, hydraulic
PLIERS
SCREWDRIVER
WRECKER or HOIST
WRENCH, open-end, $^{11}/_{32}$-in.
WRENCH, open-end, $^{7}/_{16}$-in. (2)
WRENCH, open-end, $^{1}/_{2}$-in. (2)
WRENCH, open-end, $^{9}/_{16}$-in. (2)
WRENCH, open-end, $^{5}/_{8}$-in.
WRENCH, open-end, $^{11}/_{16}$-in.
WRENCH, open-end, $^{7}/_{8}$-in.
WRENCH, open-end, $^{15}/_{16}$-in. (2)
WRENCH, open-end, 1-in.
WRENCH, open-end, $1\frac{1}{8}$-in.
WRENCH, open-end, $1\frac{1}{4}$-in.
WRENCH, open-end, $1\frac{3}{8}$-in.
WRENCH, socket, w/ratchet handle, $^{3}/_{4}$-in.
WRENCH, socket, $1\frac{1}{4}$-in.

RA PD 12498

Figure 64—Lifting Engine from Tank with Wrecker

ENGINE—R-975EC-2 AND R-975-C1

b. Procedure.

(1) LIFTING ENGINE INTO ENGINE COMPARTMENT.

WRECKER or HOIST
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 11/16-in.
WRENCH, open-end, 1¼-in.
WRENCH, socket, 1¼-in.

(a) Install lifting sling and safety chain on engine.

(b) Free engine from stand, hook lifting hook of wrecker through sling and safety chain, and lift out of stand.

(c) Remove pipe extensions.

(d) Raise boom and engine high enough to clear the rear of tank hull, and move engine over engine compartment.

(e) Lower boom sufficiently to allow engine to be lowered the balance of the way vertically. Have 2 men on rear of tank to hold engine clear of any projections in the engine compartment.

(f) Install steady rest adapters (1¼-in. open-end and 1¼-in. socket wrenches) before engine is completely lowered.

(2) SECURING THE ENGINE.

EXTENSION, long (2)
HANDLE, sliding, "t"
PLIERS (2)
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 1¼-in.
WRENCH, socket, 1¼-in.

(a) As soon as the engine is in place, with the support beam seated on the support brackets and the steady rest adapters installed on the steady rest support brackets, install and tighten the 8 bolts, nuts, and cotter pins that hold the support beam in place.

(b) Install and tighten the steady rest bolts.

(c) Connect up the ground strap on the engine support beam and install the bolt (two 9/16-in. open-end wrenches).

(d) Remove the engine lifting sling and safety chain.

(3) CONNECTIONS AT FRONT OF ENGINE.

SCREWDRIVER
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 1-in.

(a) Lining up the holes in the companion flange and the propeller shaft universal joint flange, install and tighten the 8 companion flange bolts (two 9/16-in. open-end wrenches). Be sure to pull up the bolts evenly so that the propeller shaft flange seats perfectly on the clutch companion flange.

(b) If the tank has a breather line from the oil tank to the engine, pull the breather line far enough through the bulkhead to connect up the hose connection at the top of the engine.

(c) Connect other end of breather line at the expansion tank (1-in. open-end wrench). NOTE: Do not remove cloth or tape from lines until ready to make reconnections.

(4) CONNECTING UP OIL PRESSURE GAGE AND PRIMER DISTRIBUTOR LINES.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 5/8-in.

Remove covers from oil pressure gage and primer distributor lines and connect the lines (5/8-in. and 7/16-in. open-end wrenches) below the left side of the engine.

(5) CONNECTING FUEL LINES.

WRENCH, open-end, 7/8-in.

Connect fuel inlet line (7/8-in. open-end wrench) at fuel pump and fuel bypass line at the three-way elbow on the carburetor. Be sure all connections are properly seated and tight.

(6) CONNECTING OIL LINES. NOTE: It is highly important that oil line connections be free from oil and air leaks. Care should be taken to see that all fittings are free from dirt or lint, and the connections perfectly tight.

WRENCH, open-end, 1-in. WRENCH, open-end, 1 3/8-in.

(a) Connect the oil pump inlet line at the "Y" connection for the oil dilution line (1 3/8-in. open-end wrench), using care not to injure the fittings on the other branch of the "Y".

(b) Connect the oil outlet line and the front scavenger line to the other "Y" connection (1-in. open-end wrench).

(7) INSTALLING OIL TEMPERATURE GAGE LINE AND TACHOMETER DRIVE CABLE.

WRENCH, open-end, 5/8-in.

(a) Examine the oil temperature gage bulb and connection carefully to be sure it is perfectly clean and that it will seat perfectly for an oiltight, airtight joint.

(b) Install the bulb in the finger strainer on the oil pump and tighten carefully into place (5/8-in. open-end wrench).

(c) Install the tachometer drive cable on the drive connection, tightening the knurled nut.

(8) INSTALLING SOLENOIDS.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 5/8-in.

(2)

(a) Install and tighten (two 7/16-in. open-end wrenches) the fuel cut-off solenoid on the bracket on the right side of the engine support beam, inserting the cable in the clip on the left side of the engine support beam and tightening (two 7/16-in. open-end wrenches).

(b) Connect up linkage to fuel cut-off rod by installing clevis over arm, installing clevis pin and securing it with a cotter pin.

(c) If engine has an oil dilution valve, install and tighten (5/8-in. open-end wrench) the solenoid on the bracket on the left side of the engine support beam, and connect the fuel line from the carburetor to the valve.

(9) MAKING ELECTRICAL CONNECTIONS.

PLIERS
SCREWDRIVER
WRENCH, open-end, 11/32-in.
WRENCH, open-end, 3/8-in.

(a) Connect up the magneto ground wires and the booster primary wire (11/32-in. open-end wrench), threading through the top hole in the terminal box and connecting, as tagged or otherwise indicated, to the proper terminals.

(b) Install and tighten the conduit connection to the terminal box by hand and install the terminal box cover (screwdriver).

(c) Install the generator wires on the terminals inside the shield; replace the shield cover, and install and tighten the conduit connection by hand.

(d) Install the starter cable on the starter terminal inside the shield.

(e) Replace the shield cover and install and tighten the conduit connection by hand.

(f) Install locking wire (pliers) through boltheads on both shield covers.

(10) INSTALLING LOWER AIR INTAKE TUBES.

SCREWDRIVER

(a) Install the lower air intake tubes to the lower openings in the air cleaner housings by means of the flexible hose couplings (screwdriver).

(b) Remove cloth from carburetor air horns; slide bellows type connectors over the air horns, and tighten the clamps (screwdriver). NOTE: The connections on the lower air intake tubes must be completely airtight, to prevent particles of dirt or dust from entering the induction system at these points.

(c) If the engine has a nose breather connection, install the pipe in the flexible connection (screwdriver) just above the engine support beam, being sure the connection is completely airtight and dusttight.

(11) INSTALLING THE UPPER HALF OF THE ENGINE COMPARTMENT SHROUD.

SCREWDRIVER
WRENCH, open-end, 1 3/8-in.
WRENCH, open-end, 7/16-in.

(a) Slide the shroud forward and down into place.

(b) Insert the exhaust pipe from the auxiliary generator into the clamp and tighten to secure ($^{7}/_{16}$-in. open-end wrench).

(c) Connect up the right and left engine compartment fire extinguisher lines (1⅜-in. open-end wrench) and connect the main fire extinguisher line at the bulkhead.

(d) Slide the 2 upper air intake pipes through the ports in the shroud, being sure that the openings on the fan compartment end are pointed *down.*

(e) Attach rear ends to flexible connections on air cleaners (screwdriver).

(12) INSTALLING MUFFLER ASSEMBLY.

WRENCH, open-end, ½-in.
WRENCH, open-end, $^{9}/_{16}$-in. (2)

(a) Install the muffler assembly down through the top of the engine compartment, sliding it down and to the rear.

(b) Remove cloth from exhaust openings, line up elbows and No. 9 and No. 1 stacks, slide connector bands into place and snap them tight.

(c) Line up the holes in the muffler support beam and the support bracket on the top of the engine support beam and install and tighten the bolt (two $^{9}/_{16}$-in. open-end wrenches).

(d) Bolt the rear support rods to the muffler support beam (½-in. and $^{5}/_{16}$-in. open-end wrenches).

(13) INSTALL THE CARBURETOR INSPECTION PLATE.

JACK, hydraulic
PLIERS
WRENCH, socket, w/ratchet handle, ¾-in.

(a) From beneath the tank, reach up through the carburetor inspection opening and connect up the carburetor throttle linkage.

(b) Use a hydraulic jack and lift the inspection plate into place, holding it in place with the jack after lining up the cap screw holes.

(c) Install and tighten the cap screws and remove the jack (¾-in. socket wrench with ratchet handle).

(d) Install locking wire on cap screws (pliers).

(14) INSTALLING THE FRONT SECTION OF THE ENGINE COMPARTMENT TOP PLATE.

CHAIN
WRECKER
WRENCH, open-end, $^{9}/_{16}$-in. (2)
WRENCH, open-end, $^{15}/_{16}$-in.
WRENCH, open-end, 1⅛-in.

(a) Lift the plate into place with the wrecker, using a chain around the fan compartment cover.

(b) Install and tighten the cap screws (1⅛-in. and $^{15}/_{16}$-in. open-end wrenches) holding the plate to the hull.

(c) Install and tighten the bolts (two $^{9}/_{16}$-in. open-end wrenches), holding the upper half in place and screwing on the handles.

(15) INSTALLING THE REAR SECTION OF THE ENGINE COMPARTMENT TOP PLATE.

CHAIN	PLIERS
DRIFT	WRECKER
HAMMER	WRENCH, open-end, $^{15}/_{16}$-in. (2)

(a) Lift the plate into place with the wrecker, using a chain around the center of the plate.

(b) Engage the hinge sections of front and rear plates and drive the hinge pins into place and secure with cotter pins (hammer, drift, and pliers).

(c) Install and tighten the 3 bolts (two $^{15}/_{16}$-in. open-end wrenches) that hold the rear edge of the plate to the hull.

58. EXHAUST SYSTEM.

a. Description. The exhaust system consists of left and right exhaust manifold assemblies that lead up through elbows at the top of the exhaust ring into the 2 horizontally mounted mufflers just under the engine compartment top plates. Exhaust gases are expelled through 2 tail pipes projecting just below the rear center of the hull.

b. Removal of Mufflers (fig. 57).

(1) The entire muffler assembly can be removed as a unit (sec. XIV, par. 56 **b** (4)).

(2) REMOVAL OF THE MUFFLER.

WRENCH, ½-in. (2)	WRENCH, open-end, ¾-in.

(a) Open engine compartment rear top plate and remove the front and rear holding straps from the top of the muffler by removing the 4 nuts and bolts that hold each strap (two ½-in. wrenches).

(b) Disconnect the exhaust stack at No. 9 or No. 1 cylinder by unsnapping the connector band, and disconnect the exhaust manifold elbow from the main exhaust manifold ring by unsnapping the connector band.

(c) Loosen the U-bolt at the front of the muffler (¾-in. open-end wrench) and, by raising the muffler, work the exhaust manifold elbow out of the exhaust. The muffler and tail pipe can now be lifted forward and out. To remove tail pipe from muffler, loosen rear U-bolt and pull out pipe.

c. Installation of Mufflers.

(1) The entire muffler assembly can be installed as a unit, as described in sec. XIV, par. 57 b (12).

(2) INSTALLING ONE MUFFLER.

(a) Slide tail pipe into place in rear muffler pipe and tighten the 2 U-bolt nuts. With rear engine top plate open, slide muffler down and to the rear into place on the holding clamps.

(b) Raising muffler slightly, work exhaust manifold elbow into front pipe of muffler. Lower muffler into place and snap connector bands into place on main manifold and on No. 9 or No. 1 stack.

(c) Check tail pipe to see that it is not touching the rear hull; then, install and tighten the front and rear holding clamps. Tighten front U-bolt sufficiently to secure exhaust manifold elbow. Avoid applying too much tension to the U-bolt as it may damage the manifold elbow.

d. Replacement of Exhaust Manifold (fig. 53).

WRENCH, 9/16-in.

Exhaust stacks and the exhaust manifold rings must occasionally be replaced in entirety or more probably in part because of cracks or other injuries. The 2 exhaust manifold assemblies are so constructed that each exhaust stack and related portion of the main exhaust ring can be removed separately. In each case unsnap the connector bands for the particular manifold ring segment and slide it out of the way. Then loosen and remove the 3 cap screws (9/16-in. wrench) that hold the exhaust stack flange to the cylinder exhaust port. The new stack and segment is fastened into place against the cylinder by the flange cap screws and connected into the manifold ring by snapping the connector bands tightly into place. If an entire exhaust manifold is to be replaced, the quickest and easiest method is to remove each segment individually.

59. INTAKE PIPES (figs. 65 and 66).

a. Description. Individual intake pipes carry the fuel mixture to the intake port of each cylinder. Care should be taken to keep the connections tight at both ends of the pipes. If pipes become dented or cracked, they should be replaced.

b. Replacement of Intake Pipe Packing.

WRENCH, lug, intake pipe
packing nut

Air leaks around the intake packing require the replacement of the packing. To determine the presence of such leaks, first tighten the packing nut, then, squirt a small amount of gasoline around the nut while the engine is idling. If this causes the engine to accelerate, an air leak is present and the packing should be replaced as follows:

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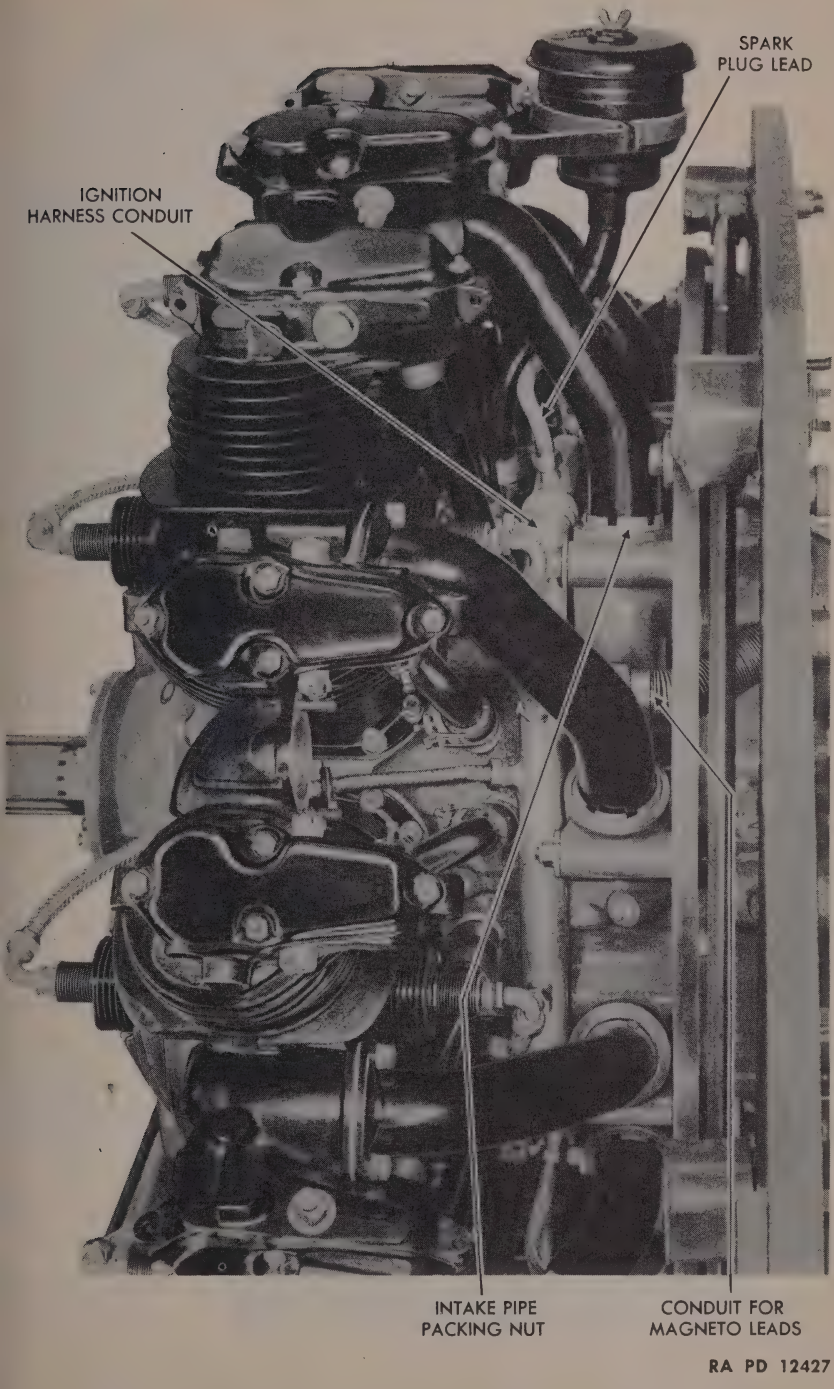

Figure 65—Detail of Ignition Harness (Exhaust Manifold Removed)

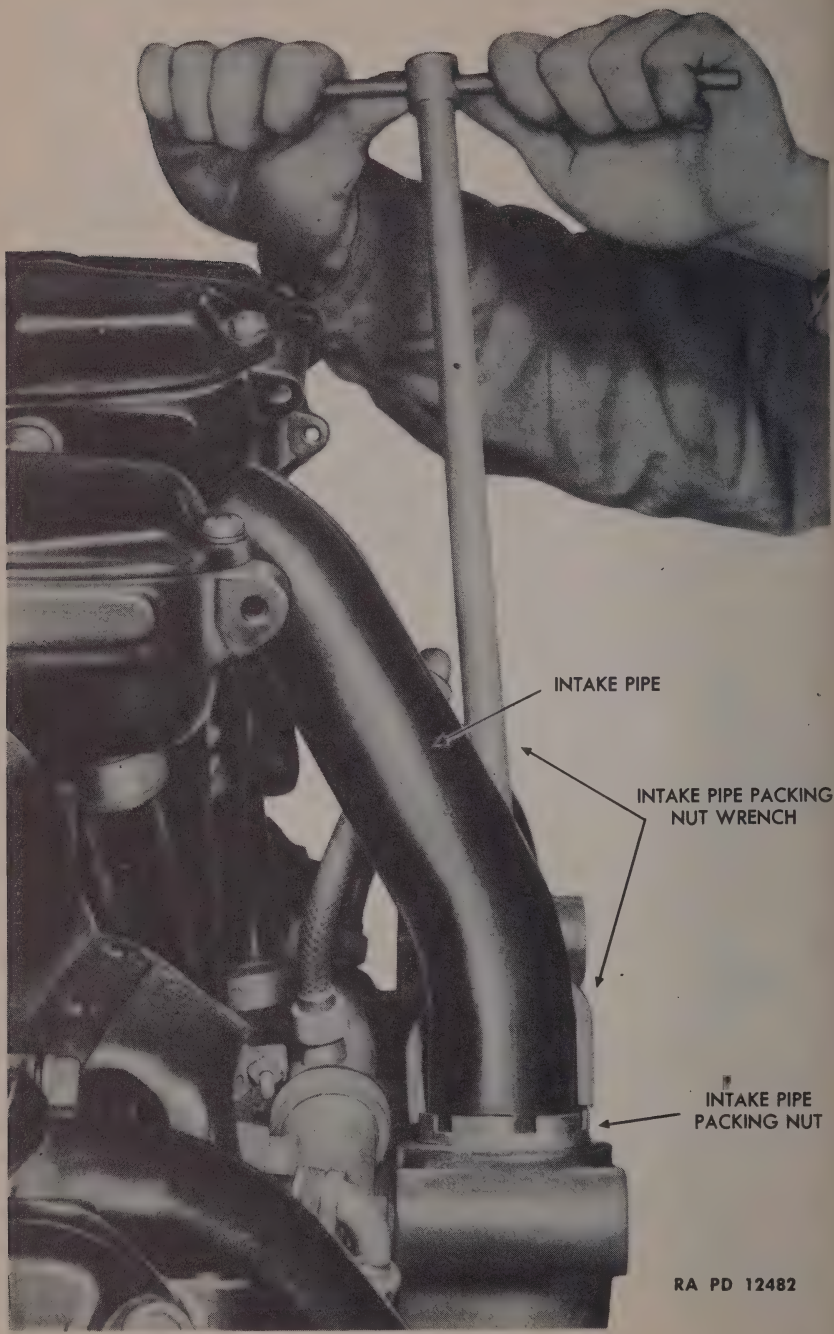

Figure 66—Use of Special Wrench to Tighten Intake Pipe Packing Nut

(1) Loosen intake pipe packing nut with special wrench (fig. 66) and slide it up on the pipe. Remove the old packing.

(2) Make long diagonal cut in the new packing, preferably using a razor blade to secure a clean edge.

(3) Spread packing and place it around intake pipe. Push it down into place with the packing nut. Be sure that the nut is properly threaded on manifold and tighten down carefully to avoid distorting the packing.

(4) REPEAT TEST FOR AIR LEAKS.

c. Removal of Intake Pipes.

WRENCH, lug, intake pipe packing nut

WRENCH, open-end, $^{9}/_{16}$-in.

(1) With special intake pipe packing nut wrench, loosen the intake pipe gland nut and turn it out all the way (fig. 66).

(2) Remove the 3 cap screws ($^{9}/_{16}$-in. open-end wrench), holding the intake pipe flange to the cylinder intake port. Pull pipe away from intake port and lift out.

(3) Lift out packing from intake manifold port.

d. Installation of Intake Pipes.

(1) Install flange and intake pipe packing nut on new pipe. Use new flange or packing nut if needed. Slide new intake pipe packing well up on intake pipe.

(2) Insert intake pipe into intake manifold port. Install cap screws through flange at top of pipe, install new gasket over the screws, and turn screws into cylinder finger tight.

(3) Make sure that intake pipe is centered in intake manifold. With the intake packing nut, push the packing down into the intake manifold. Turn the packing nut down about 2 threads, being very careful to see that it is not cross threaded on the aluminum manifold.

(4) Tighten down intake pipe flange cap screws.

(5) With intake pipe packing nut wrench, tighten nut, being careful to avoid excessive pressure which will distort the packing and cause an air leak. When packing nut is correctly tightened, the shoulder should be approximately flush with the manifold housing.

60. GOVERNOR (fig. 67).

a. Description. To prevent damage due to overspeeding of the engine, a governor is provided on the engine. Centrifugal weights within the governor vary in position with the speed of the engine and actuate a lever and linkage which close a butterfly valve in the throttle box when the engine reaches the prescribed maximum speed. The proper adjustment of the governor is made when it is installed on the engine and the

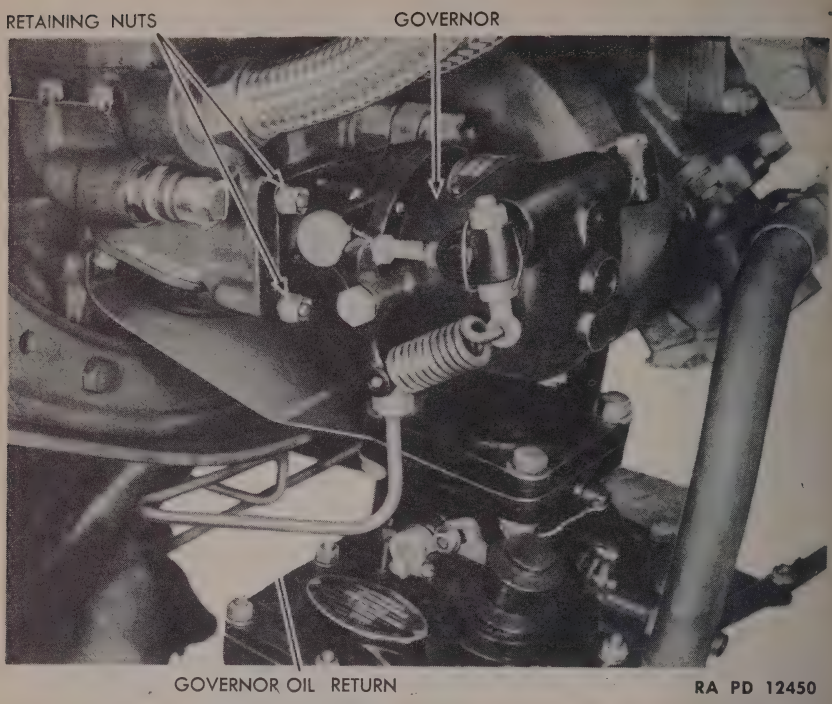

Figure 67—Left Side of Engine Governor

cap over the adjusting screw wired and sealed. This adjustment should not be tampered with. If the governor operation is faulty, the governor should be removed and replaced. The governor must also be removed if the oil pump is to be replaced.

b. Removal of the Governor.

PLIERS
WRENCH, open-end $\frac{7}{16}$-in.
WRENCH, open-end $\frac{5}{8}$-in.

(1) Disconnect the oil return line at the connection on the governor ($\frac{5}{8}$-in. open-end wrench).

(2) Disconnect governor linkage by removing cotter pin (pliers) from the lower link clevis pin and remove the clevis pin.

(3) Remove the 4 self-locking nuts holding the governor to the oil pump and pull the governor off the studs.

c. Installation of the Governor.

(1) Install governor on the 4 studs on the oil pump and secure by installing and tightening the 4 self-locking nuts.

(2) Connect up the governor linkage by inserting the clevis pin in the lower link and throttle box arm. Secure with cotter pin.

(3) Connect up governor oil return line. NOTE: This procedure applies to the reinstallation of the governor after replacement of oil pump. If new governor is to be installed, it must be installed and adjusted by ordnance maintenance personnel.

61. ROCKER ARMS (fig. 68).

a. General. Rocker arms at the top of each cylinder open and close the intake and exhaust valves and are operated by means of the cam and push rod mechanism. A roller at the valve end of the rocker arm contacts the end of the valve stem. A roller bearing is used where the rocker arm is supported on the rocker shaft. The push rod end of the rocker arm is split and tapped to provide for an adjusting screw, used to set the valve clearance at the correct amount. A clamping screw keeps the adjusting screw from turning once it has been properly set.

b. Inspections. Rocker arms should be inspected for worn bearings, and for flat spots on the roller. If there are any evidences of wear, the arm should be replaced.

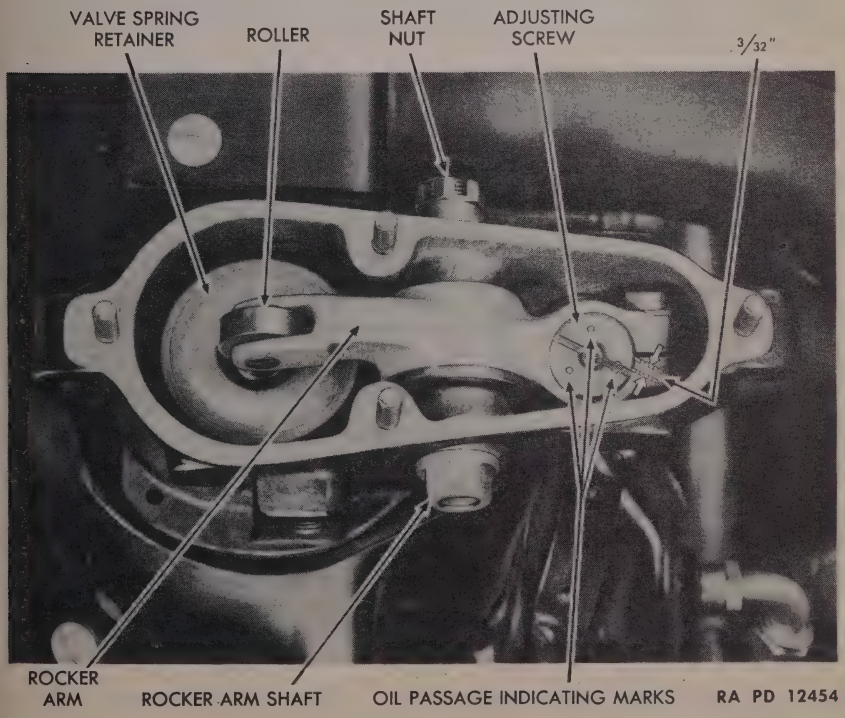

Figure 68—Interior of Rocker Box

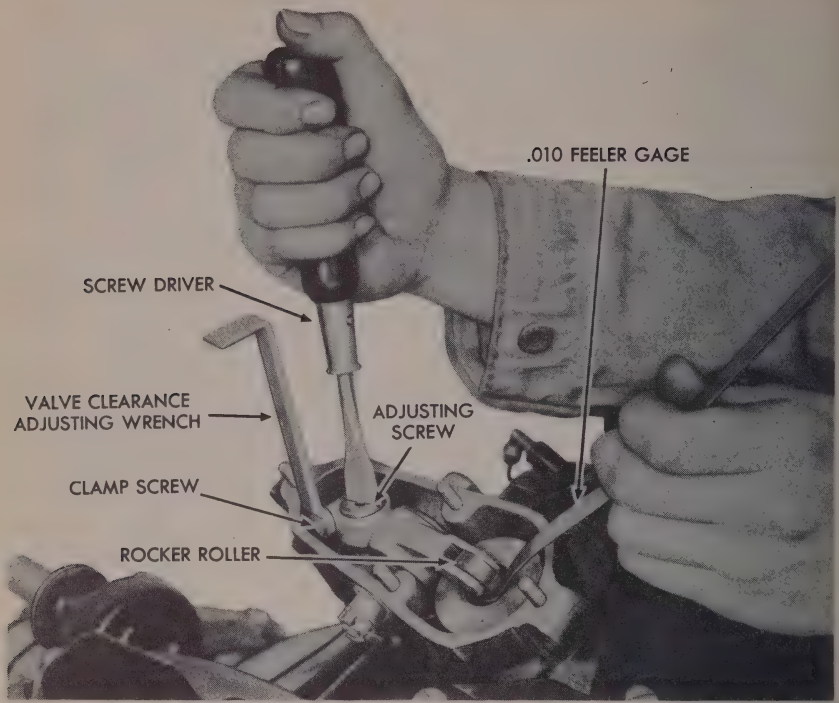

Figure 69—Adjusting Valve Clearance

c. Removal of Rocker Arm (fig. 70).

HAMMER and drift (3/8-in. by 4-in.)
PLIERS
WRENCH, box, 7/16-in.
WRENCH, box, 1 1/16-in.
WRENCH, open-end, 5/8-in.

(1) Remove rocker box covers and gaskets from the cylinder (7/16-in. box wrench).

(2) Turn the engine with the starting crank until the cylinder is on compression stroke, freeing the rocker arm.

(3) Remove cotter pin from nut on rocker arm shaft. Hold shaft with 5/8-in. wrench and remove nut (1 1/16-in. box wrench).

(4) Drive the shaft out with hammer and drift. Remove spacers and lift out rocker arm.

d. Installation of Rocker Arm.

GAGE, feeler
SCREWDRIVER, small
WRENCH, box, 1 1/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, valve clearance adjusting

(1) Put new rocker arm into place with spacer on each side, using

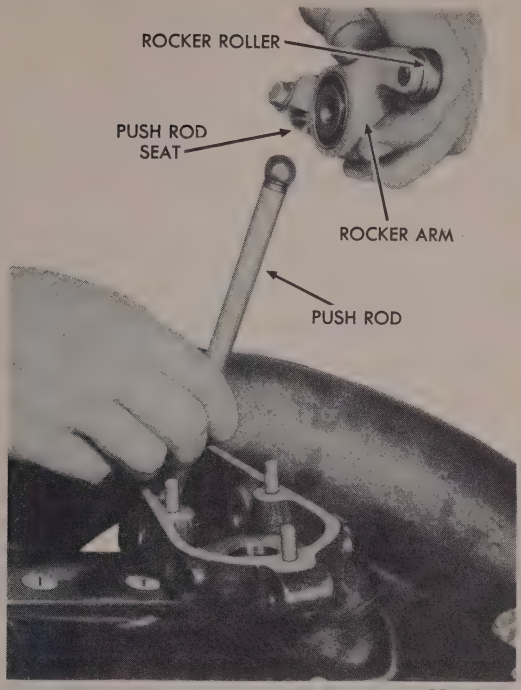

Figure 70—Removing Rocker Arm and Push Rod

a small screwdriver or rod to line up spacers with rocker arm. CAUTION: In installing new rocker arms be sure that an exhaust rocker arm is used in an exhaust rocker box. An intake rocker arm will have a different pitch, and can only be used in an intake rocker box.

(2) Put one outside spacer on rocker arm shaft and install shaft from inner side of rocker box so that the nut will be on the side toward the outer wall of the piston.

(3) Install outside spacer on other end of shaft, and install and tighten nut. Secure nut with cotter pin.

(4) Adjust valve clearance (par. 63).

62. PUSH RODS (fig. 70).

a. Oil for valve mechanism lubrication is delivered through oil passages in the push rods. For that reason, when a rocker arm is removed, the push rod should be lifted out and inspected for clogged oil passage. After blowing passage out with compressed air, prime the passage with clean oil and put push rod back in place.

63. VALVE CLEARANCE ADJUSTMENT (figs. 68 and 69).

a. Equipment.

GAGE, feeler, 0.010
SCREWDRIVER
WRENCH, box, 7/16-in.
WRENCH, box, 11/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, socket, 1-in. No. 140
WRENCH, valve clearance adjusting

b. Procedure.

(1) PRELIMINARY STEPS. Remove rocker box covers and gaskets from all cylinders (7/16-in. box wrench). Remove front or rear spark plugs (1-in. No. 140 socket wrench). Turn engine crankshaft until the piston in the cylinder to be adjusted is at top dead center on the firing stroke. (This can be seen through the spark plug hole.) If the rocker arm rollers on both the intake and exhaust valves are free, the valve adjustment can be made. If either valve is not free when the piston is at top dead center, the piston is on the exhaust stroke. Turning the crankshaft a complete revolution will bring the piston to top dead center on the compression stroke, and free both rocker arm rollers. Before adjusting valve clearance, check the rocker arm roller for flat spots or burs. Check rocker arm for excessive side play. Replace rocker arm, if necessary (par. 61).

(2) ADJUSTING CLEARANCE (fig. 68). Using the valve clearance adjusting wrench, loosen the clamping screw (3/8-in. open-end wrench). Insert a 0.010 feeler gage between the valve stem and the rocker roller, and, with a screwdriver, adjust the adjusting screw until the gage will slide in and out smoothly, causing the roller to turn. CAUTION: Hold down on push rod end of rocker arm when checking clearance.

(3) CHECKING POSITION OF ADJUSTING SCREW (fig. 68). The adjusting screw has 3 radially-drilled oilholes to permit pressure lubrication of the upper 8 rocker arms. To be sure that each of these holes is blanked off from the split in the rocker arm, the location is marked by 3 zeros on the head of the screw. No hole should be closer than 3/32 of an inch from the nearest edge of the split. If the proper 0.010 clearance should bring one of the zeros closer than 3/32 inch to the split in the rocker arm, move the adjusting screw in the shortest direction to bring the zero to 3/32 inch from the split.

(4) LOCKING THE ADJUSTMENT. Tighten clamping screw with special wrench or 3/8-inch open-end wrench. Test tightness by trying to turn adjusting screw with screwdriver. If clamping screw is properly tightened, it will be impossible to turn adjusting screw.

64. VALVE SPRINGS.

a. Description. Each valve is held firmly against the seat by means of 3 concentric compression springs, seated on 3 washers at the bottom

and on a shouldered washer at the top. A split lock ring seats in a groove in the valve stem and holds the upper shouldered washer in place on the valve. Should a valve spring become broken, replace it, otherwise faulty operation may result. To determine whether or not a valve spring is broken, remove the rocker box covers and inspect the outside portions of the springs that are visible in the rocker arm box. If a spring appears to be sticking out, it is probably broken.

b. Removal of Valve Spring (fig. 71).

SUPPORT, padded valve	WRENCH, box, $\frac{7}{16}$-in.
TOOL, valve spring compressing WR81409	WRENCH, socket, 1-in. No. 140

(1) Remove rocker box covers and gaskets from all cylinders (2 in box wrench).

(2) Remove the spark plugs (1-in. No. 140 socket wrench) and turn the engine over with a crank until the rocker arm is free.

(3) Remove the rocker arm (par. 61 c).

(4) Install the valve spring compressing tool (WR 81409) by placing the flat portion of the tool over the springs, with the lugs down and the

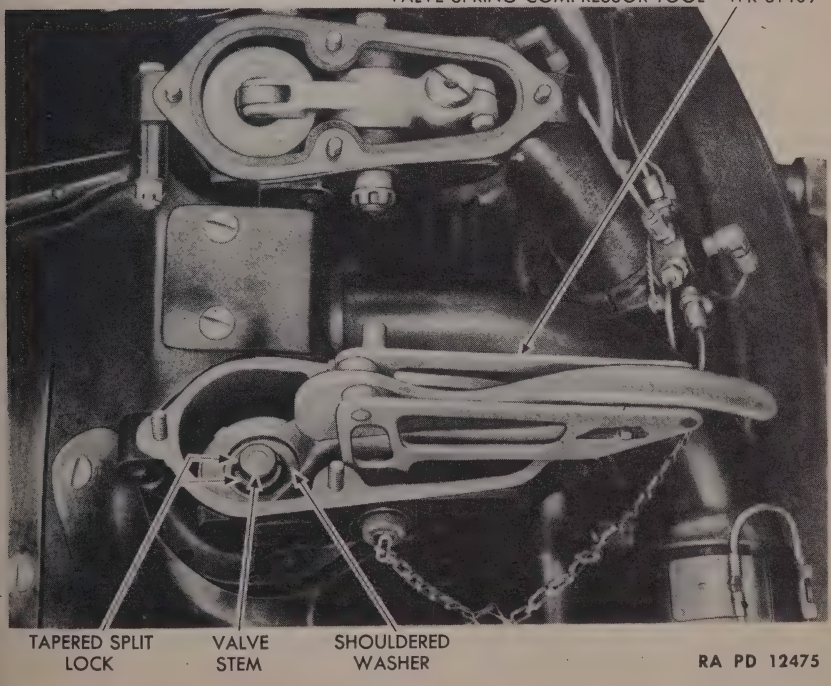

Figure 71—Compressing Valve Springs to Remove Split Lock

compressing handle up. Press down on the tool until the holes in the body of the tool line up with the rocker arm shaft holes in the rocker box, and place the compressing tool pin into the holes. Compress the springs (fig. 71), using a support through the spark plug hole to keep the valve from dropping down into the cylinder. Make sure that the support is padded with cloth to prevent damage to the spark plug hole threads.

(5) Lift out the 2 halves of the tapered split lock and release the compressing tool.

(6) Lift out the shouldered washer.

(7) Remove the 3 concentric valve springs and inspect for breakage.

(8) Remove the 3 washers forming bottom spring seats. Replace if worn or damaged.

c. Installation of Valve Spring.

SUPPORT, padded valve
TOOL, valve spring compressing, WR 81409
WRENCH, box, 7/16-in.
WRENCH, socket, 1-in. No. 140

(1) Install the 3 washers that form the bottom spring seats.

(2) Install the 3 concentric springs.

(3) Install the shouldered washer.

(4) Install the valve spring compressing tool and depress washer.

(5) Install the 2 halves of the split lock.

(6) Remove the compressor tool and remove valve support from within cylinder.

(7) Replace the rocker arm (par. 61 **d**, **e**).

(8) Adjust valve clearance (par. 63).

(9) Install rocker box cover (7/16-in. box wrench).

65. REFERENCES.

a. General. Engine accessories have been covered in connection with the fuel, lubrication, electrical, and ignition systems.

b. Organization.

Accessory	Section
Carburetor	Fuel system (XV)
Fuel filter	Fuel system
Bypass pressure regulation valve	Fuel system
Fuel lines	Fuel system
Primer pump	Fuel system
Fuel tanks	Fuel system

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Accessory	Section
Oil pump	Lubrication system (XVII)
Oil reservoir	Lubrication system
Oil filter	Lubrication system
Oil cooler	Lubrication system
Clutch	Clutch (XVIII)
Generator	Electrical and ignition systems (XXII)
Solenoids	Electrical and ignition systems
Ignition shielding harness	Electrical and ignition systems
Spark plugs	Electrical and ignition systems
Starting motor	Electrical and ignition systems
Magnetos	Electrical and ignition systems

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Section XV

FUEL SYSTEM

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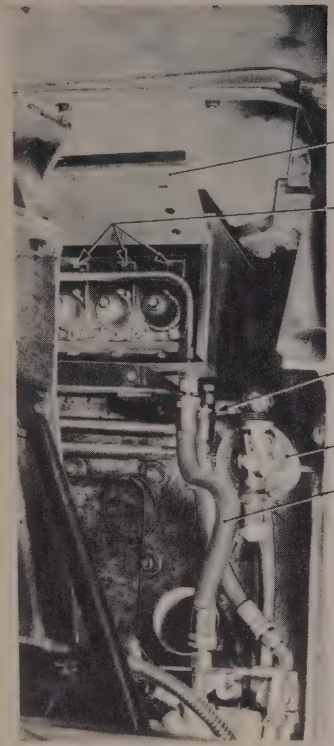
Grades of engine gasoline	78

66. DESCRIPTION (fig. 73).

a. Fuel is supplied to the carburetor at a pressure of approximately three and one-half pounds by the system diagrammed in figure 73. From any or all of the four fuel tanks, fuel goes to a collector or header line. From there it is drawn through the fuel filter and up into the fuel pump located just above and to the right of the carburetor. From the fuel pump it is forced to the carburetor. A bypass line at the carburetor fuel inlet permits fuel, in excess of carburetor requirements, to return through a bypass pressure regulator valve which thus regulates the pressure of the fuel fed to the carburetor. Fuel passing through the bypass pressure regular valve returns to the header for recirculation. A fuel line connects the header to the primer pump, located on the instrument panel. Upon operation of the pump plunger the fuel drawn in is forced back to the priming distributor and priming lines into the top five cylinders. An oil dilution system is fed by a fuel line connecting with the fuel system at the carburetor inlet. When the valve is opened, fuel is allowed to enter the oil inlet line to thin the oil in the engine for cold weather starting.

67. INSPECTION.

a. All connections and fuel lines should be given continual inspections for signs of leaks and any evidence of damage or wear. Care should be taken to maintain all flexible lines in position so that they are not subjected to twisting or to abrasion through rubbing against some other



TOP VIEW

TUBE (ROMEC PUMP TO RELIEF VALVE)

COVER

CAP SCREWS

CAP SCREW

CAP SCREW WASHER

FILTER BOWL

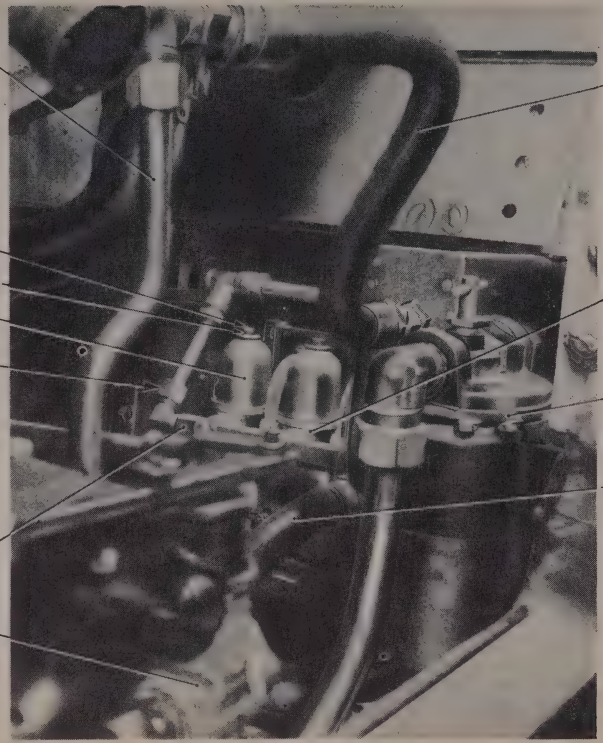
UNION

OIL FILTER

DISCHARGE LINE

INTAKE HEADER

RELIEF VALVE



SIDE VIEW

HOSE (INTAKE TO ROMEC PUMP)

AUTOPULSE FUEL PUMPS

OIL FILTER

HOSE (AUTOPULSE TO RELIEF VALVE)

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Figure 72—Installation of Autopulse Fuel Pump

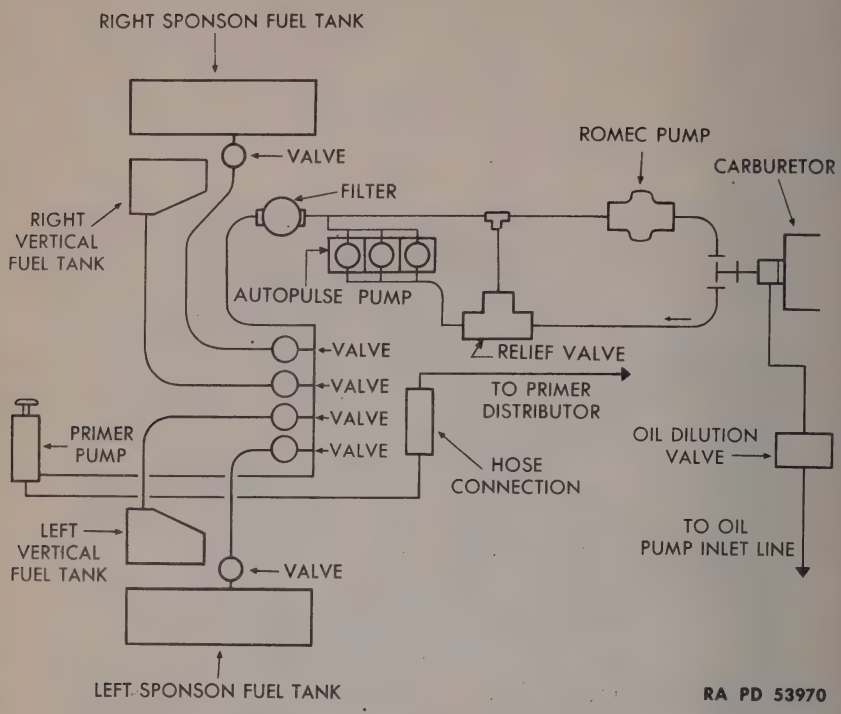

Figure 73—Diagram of Fuel System

line or part. The carburetor should be checked for signs of leakage and the carburetor elbow examined for cracks. All air intake connections should be continually checked for tightness and for the presence of even the smallest holes.

68. TROUBLE SHOOTING.

a. Since trouble shooting in the fuel system is so closely connected with engine trouble shooting, it has already been covered in paragraph 55, section XIV, "Engine trouble shooting."

69. TANKS.

a. Description (fig. 73). Four fuel tanks, with a total capacity of 185 gallons, are provided for the engine fuel system. Two vertical tanks, each of 32½ gallons capacity, are located in the front corners of the engine compartment; and 2 horizontal tanks, of 60 gallons capacity, are located one in each side of the engine compartment in the sponson. A separate gasoline tank with a capacity of 5 gallons for the auxiliary generator is located in front of the left horizontal tank.

b. Drains. The vertical tanks can be drained by removing a drain plug at the bottom of the tank. To reach drain plug, a 1½-inch pipe plug in the floor, located beneath the drain plug, must be removed. To drain the horizontal tank, remove circular plate located at rear and bottom of sponson, and remove drain plug.

70. FUEL PUMPS (figs. 60 and 72).

a. Romec Pump.

(1) DESCRIPTION. The fuel pump is mounted on the engine accessory drive housing to the right of the generator. The pump is mounted on a base which is installed on the housing.

(2) MAINTENANCE. At the daily inspection, check for leakage at the joints and fittings. If there is doubt about the pump operation, disconnect the inlet line at the carburetor, hold it over an open container and turn the engine over with the starter. If no fuel is delivered at the inlet line, the pump is defective and should be replaced.

(3) REMOVAL OF FUEL PUMP.

SCREWDRIVER
WRENCH, open-end, 7/8-in.
WRENCH, open-end, 7/16-in.

(a) Disconnect the fuel lines at each side of the pump (7/8-in. open-end wrench). Mark lines "inlet" and "outlet."

(b) Using a 7/16-inch open-end wrench, remove the four self-locking nuts that hold the pump to the accessory drive housing and move the pump off the studs.

(4) INSTALLATION OF FUEL PUMP.

SCREWDRIVER
WRENCH, open-end, 7/8-in.
WRENCH, open-end, 7/16-in.

(a) Inspect the new pump to see that the connections on the pump come out over the long sides of the base. If necessary, turn the pump on the base by removing the four screws on the under side of the base and relocating the pump in the correct position.

(b) Install the base of the pump on the studs and install and tighten the four nuts.

(c) Connect the fuel lines at each side of the pump.

b. Autopulse Fuel Pump (figs. 72 and 73).

(1) DESCRIPTION. The Autopulse three-unit fuel pump is used primarily to overcome vapor-lock, but it can be used as the main fuel pump in the event of failure of the Romec pump. It is located on the right side of the engine compartment and controlled by a toggle switch on the instrument panel. This pump will be operated only when it is necessary to overcome vapor-lock in the system when the fuel becomes warm.

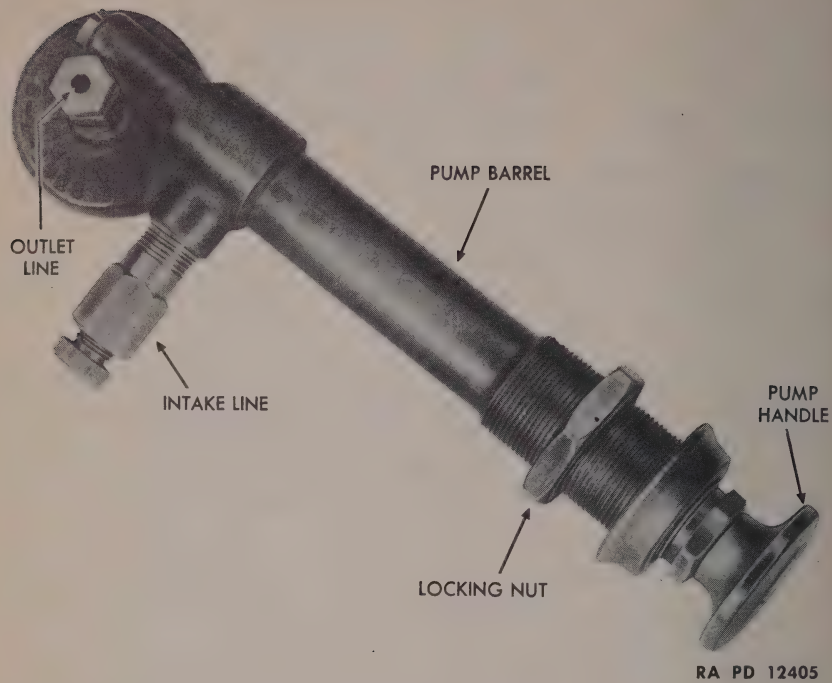

Figure 74—Primer Pump

(2) REPLACEMENT.

WRENCH, open-end, $^{7}/_{16}$-in. WRENCH, open-end, $^{15}/_{16}$-in.
WRENCH, open-end, ¾-in.

(a) Disconnect electric cable (¾-in. open-end wrench).

(b) Open fuel pump box by unfastening the latch.

(c) Unscrew the union ($^{15}/_{16}$-in. open-end wrench) at elbow connection on intake header of fuel pumps.

(d) Through the slot in the end of the box disconnect union ($^{15}/_{16}$-in. open-end wrench) from discharge header of fuel pumps.

(e) Loosen union ($^{15}/_{16}$-in. open-end wrench) through box so tube will clear elbow connections on discharge header.

(f) Remove six cap screws ($^{7}/_{16}$-in. open-end wrench) holding brackets of fuel pump to box and lift out the pump units.

(g) Reverse the procedure to install the unit.

(3) MAINTENANCE. The maintenance operations that can be done by the using arms consist of servicing and cleaning the filter and the valves.

(a) SERVICING THE FILTER. Remove the cap screw, cap screw gasket, cap screw washer, and cap screw washer gasket. Then, lift out the filter

bowl screen retaining spring and filter screen. Clean all parts in SOLVENT, dry-cleaning. Replace screen if damaged. Examine the filter base gasket for cracks and replace if damaged. Reverse the procedure to assemble the unit.

(b) SERVICING THE VALVES. With the filter screen and gasket removed as in (*a*), remove the two screws and lock washers holding the filter base in place. Remove the filter base and gasket, after which the valve and the valve gasket can be removed. Clean all parts; replace valves if warped or excessively worn. Valve seats may be resurfaced using CLOTH, crocus. New gaskets should be used if they are cracked or damaged. Reverse the procedure to assemble the unit.

71. PRIMER PUMP (figs. 11, 74, and 75).

a. Description and Operation. A primer pump, located on the instrument board, provides a means of injecting a spray of fuel into the engine intake manifold to facilitate starting. The pulling stroke of the primer draws a charge of gasoline into the primer cylinder. During the return or charging stroke, the charge is delivered to a small distribution housing from which five lines run to the top five intake manifold

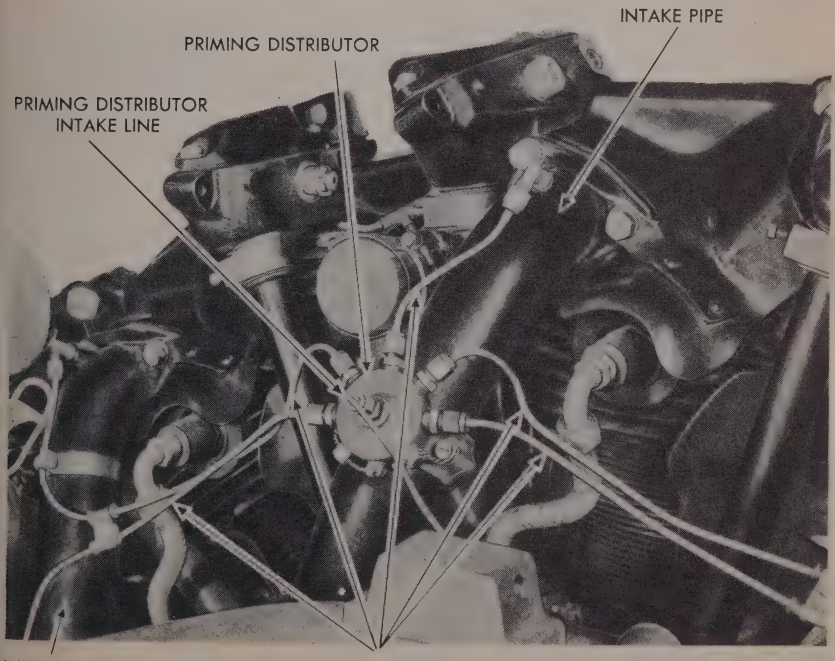

Figure 75—Priming Distributor and Lines

pipes (fig. 75). To thoroughly atomize the gasoline, pull the primer plunger out slowly and push it in quickly.

b. Maintenance (fig. 74). If more than a few strokes are required to prime the engine, the leather packing on the instrument panel end of the plunger should be checked for leakage. To stop leakage, compress packing by half turns on the packing nut located behind the priming plunger button on instrument panel until the leakage stops. If the primer pump no longer delivers gasoline to the engine, as evidenced by lack of resistance to pumphandle operation, the primer pump should be replaced.

c. Removal of Primer Pump (figs. 11 and 74).

SCREWDRIVER (short shank)
WRENCH, open-end, 3/8-in.
WRENCH, open-end 9/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 7/8-in.

(1) Remove the back plate from the instrument panel (screwdriver with short shank).

(2) Remove the nut (1 1/16-in. open-end wrench) that holds the instrument panel top supporting bolt to the bracket on the hull.

(3) Reaching around through the back of the panel, remove the nuts (9/16-in. open-end wrench) from the panel hold-down studs.

(4) Tilt the instrument panel forward and remove the inlet and outlet lines (3/8-in. open-end wrench) from the back end of the primer pump.

(5) At the rear of the panel, loosen the locking nut that holds the pump to the panel (7/8-in. open-end wrench).

(6) By hand, remove the special nut on the front end of the pump barrel and pull out the plunger. Pull the pump out of the panel from the rear.

d. Installation of Primer Pump.

SCREWDRIVER
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 7/8-in.

(1) Remove plunger and special nut from new or replacement primer pump and install the threaded end of the barrel through from the rear of the panel.

(2) Install plunger and special nut on panel end of pump and tighten the locking nut from the back.

(3) Connect inlet and outlet lines at the side and end of the pump.

(4) Push panel in correct position; install and tighten the nuts on the hold-down studs; then, tighten the nut on the top supporting bolt. Screw the rear plate into place.

e. Replacement of Primer Lines (fig. 75).

WRENCH, open-end, 3/8-in.

Broken or damaged priming lines can readily be replaced without need of special tools. Care should be taken not to dent the new lines or constrict them by making sharp bends. The intake line to the distributor can be replaced by disconnecting it at the center fitting on the distributor (3/8-in. open-end wrench) and at the flexible coupling underneath the engine. Be sure to loosen the three clips that hold the line to the engine support beam. If replacing the lines to any but the number one (top) cylinder, keep the two adjoining lines separated by means of the spacing clip (fig. 75). Shape lines so that they will not rub against projections on the engine, particularly such things as spark plug elbows and ignition harness. In replacing the inlet line to the distributor, secure the line with the three clips on the engine support beam, to protect it against vibration.

72. CARBURETOR (figs. 76 and 77).

a. Description. The carburetor is attached to the intake manifold through the carburetor elbow and governor throttle box and is located near the bottom of the engine.

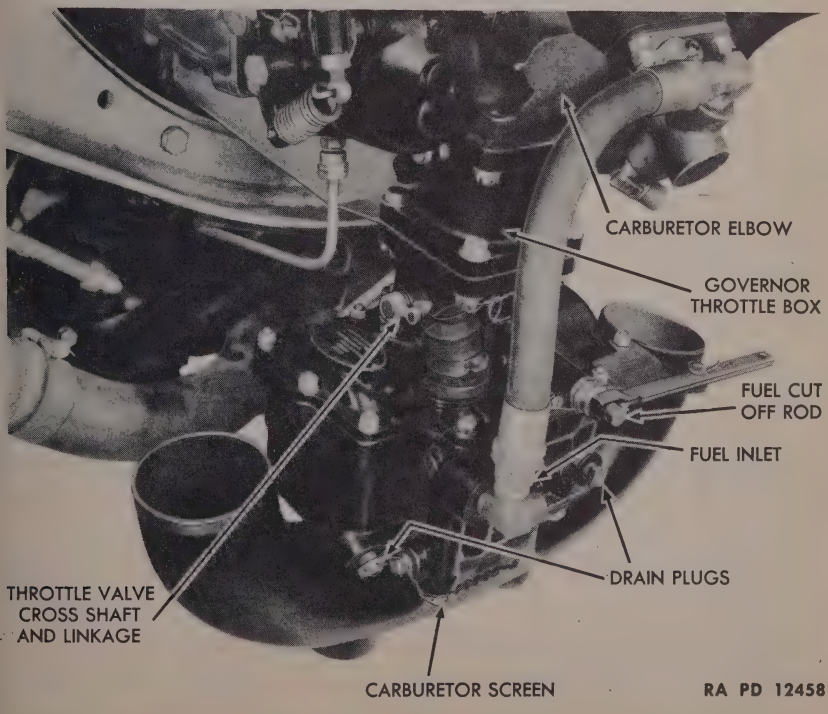

Figure 76—Left Side of Carburetor

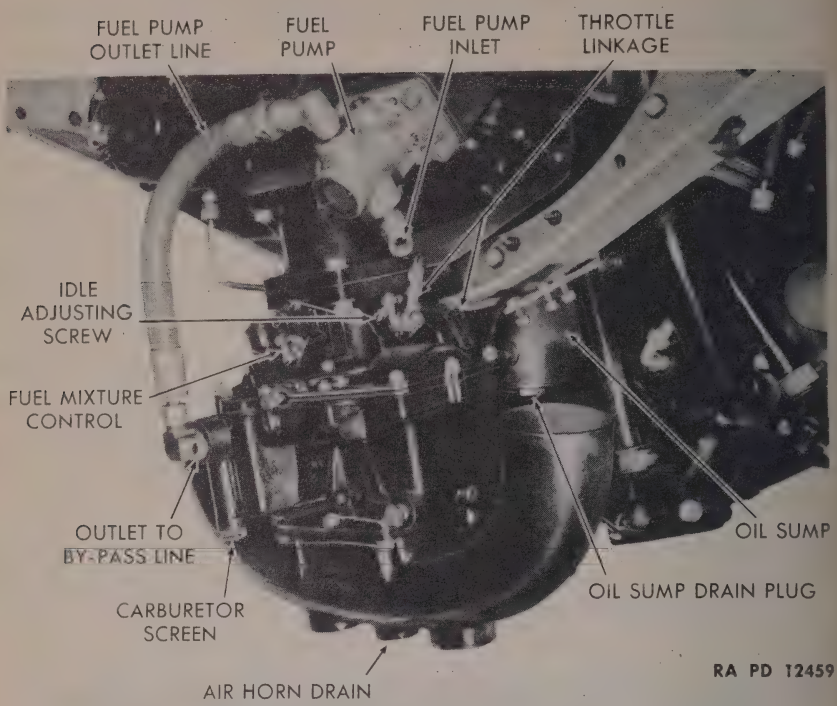

Figure 77—Right Side of Carburetor

b. Maintenance. Once the carburetor is properly installed, very little attention is needed between major engine overhauls. A fuel strainer is located in the rear left center of the carburetor where the bypass line leaves the carburetor, and may be reached by the removal of the large square-head plug at the bottom of the carburetor. A small square-head plug is provided as a drain in the bottom of each float chamber. The strainer and drain plugs should be removed frequently to remove the accumulated dirt. The fuel supply should be shut off before removing the plugs. The entire carburetor should be inspected to see that all parts are tight and properly safety-wired. In case of faulty operation, the carburetor should be replaced. No repairs are to be made by the using arms.

c. Removal of Carburetor (figs. 60, 76 and 77).

PLIERS
SCREWDRIVER
WRENCH, 1⅛-in.
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, ⅞-in.

(1) Open engine doors.

(2) Disconnect lower clamps from bellows type flexible couplings at

lower end of lower air intake tubes, and remove couplings from carburetor air horns. Cover air horns with cloth.

(3) Disconnect the fuel line from the fuel pump to the carburetor (fig. 60) at the elbow on the carburetor (7/8-in. open-end wrench and 1 1/8-in. wrench to hold line).

(4) If engine has oil dilution valve, disconnect the oil dilution fuel line from the carburetor at the solenoid valve (9/16-in. open-end wrench).

(5) Disconnect the fuel bypass return line at the elbow on the carburetor.

(6) Remove the cotter pin and clevis pin from the fuel cut-off arm, disconnecting the linkage (fig. 76).

(7) Remove the cotter pin and clevis pin from the clevis on the accelerator rod (right side of the carburetor), disconnecting the throttle linkage (fig. 77).

(8) Remove the locking wire (cutting pliers) from the nuts that hold the carburetor to the lower flange of the governor throttle box. While supporting the carburetor, remove the nuts (two 9/16-in. open-end wrenches) and remove the carburetor from the studs.

d. Installation of Carburetor.

SCREWDRIVER
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 7/8-in.
WRENCH, open-end, 1 1/8-in.

(1) Install new carburetor on studs, install and tighten nuts, and install locking wire.

(2) Install accelerator rod clevis over throttle arm; insert clevis pin and secure with cotter pin.

(3) Install clevis on fuel cut-off solenoid switch rod over fuel cut-off arm. Insert clevis pin and secure with cotter pin.

(4) Connect the fuel bypass return line into the elbow on the carburetor.

(5) Connect oil dilution line to oil dilution valve.

(6) Connect fuel line from fuel pump to elbow on carburetor.

(7) Remove tape or cloth from air horns; slip air intake bellows connections over air horns and tighten clamps.

e. Adjustment (fig. 77).

a. After a new carburetor is installed, it should be adjusted to the engine. Two adjustments are provided, one for idling speed and the other for mixture quality. The throttle adjustment on the carburetor is set so that the engine idles between 300 to 400 revolutions per minute

as read on the tachometer. The mixture control lever is moved to the right (lean) until the engine begins to run unevenly. The lever is then moved one notch at a time to the left (rich) until the engine operates evenly.

73. AIR CLEANERS.

a. Description (figs. 14 and 78). The two air cleaners provided with these medium tanks are of the heavy-duty, oil-bath type. Air enters the cleaner housing through the upper air intake pipe and is drawn down along the four corners of the housing to the baffle. With a swirling motion, caused by the baffle, the dust-laden air hits the pool of oil in the center of the baffle (fig. 14), dropping most of the dirt into the oil. The air is then drawn up through the removable filter section and the fixed filter above that and out into the lower intake pipe. Some oil is picked up by the air and carried up into the filter elements, adding to their effectiveness in removing any dirt remaining in the air. When the engine is stopped, this oil, with its dirt, drains down into the oil reservor. All dirt is collected below the baffle, in the bottom of the reservoir.

b. Maintenance. In addition to the daily service given to the air cleaners (par. 7), the condition of the entire air intake system, including the air cleaners, should be given regular and careful inspection. It is particularly important to check all flexible connections between the cleaner and the carburetor air horns since the presence of even a very small hole or leak would allow a surprising amount of dirt or dust to enter the engine. Under ordinary conditions, it is sufficient to service the air cleaners once a day. However, under very dusty conditions, it may be necessary to change the oil in the air cleaners at every halt. It is seldom necessary to clean the upper filter section of the cleaner. However, if inspection of the lower filter section indicates the presence of an excessive amount of dirt, the cleaner housing and upper filter section can be removed from the tank and the filter flushed out with cleaning solvent.

74. FUEL CUT-OFF.

a. Description. The fuel cut-off consists of a spring loaded needle valve located in such a position in the carburetor, that when it is open, the suction from the idle discharge nozzle is diverted from the idle tube to the space behind the Venturi, thereby causing the flow of fuel from the idle discharge nozzle to stop which causes the engine to cease firing immediately. For remote control purpose it is solenoid operated. The solenoid is connected to the fuel cut-off by an adjustable linkage, and operated by a toggle switch mounted on the instrument panel.

FUEL SYSTEM

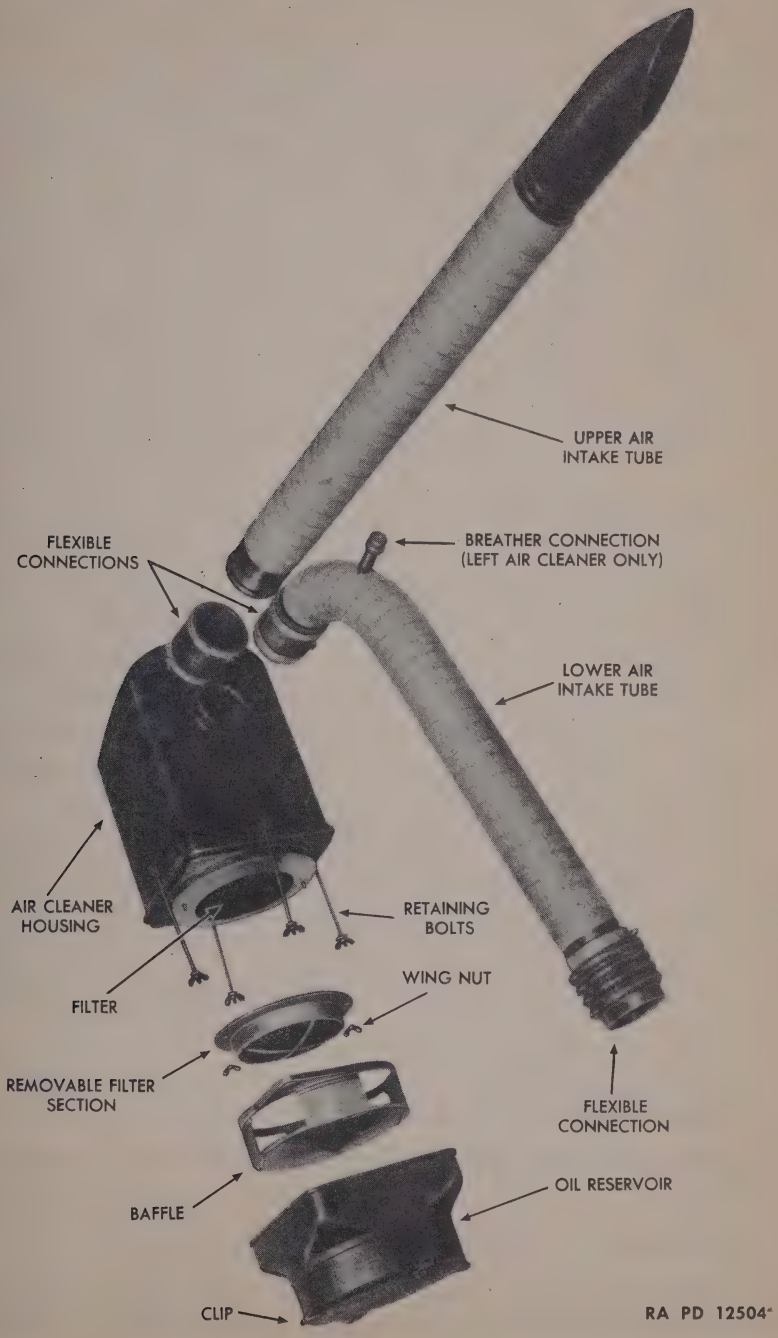

Figure 78—Component Parts of Air Cleaner

b. Maintenance. The fuel cut-off valve requires little attention other than to be sure that the solenoid is in working order and that the linkage is adjusted to the correct length for full opening of the valve and free return of the solenoid to the closed position when the switch is turned off. The linkage is adjusted by removing the clevis pin and turning the clevis in or out to secure the correct position. If the solenoid is inoperative, it should be immediately replaced.

75. FUEL FILTER.

a. Identical filters are used for the fuel system and the lubrication system. While these filters are highly efficient and self-cleaning if the handle is turned a complete turn in either direction daily, they should be drained every 50 hours, and removed, disassembled, and cleaned every 100 hours (pars. 50 and 51). Complete description and maintenance of the fuel filter are the same as that of the oil filter (par. 85).

76. FUEL LINES AND VALVES.

a. Fuel Lines. All fuel lines are loom-covered where necessary for protection against rubbing and traffic. Frequent inspections of all lines and connections should be made to insure against fuel leaks.

(1) MAINTENANCE. At the 100-hour check, all fuel lines should be removed, carefully inspected, and blown out with compressed air.

(2) REPLACEMENT. When a defective fuel line is to be replaced, it is of extreme importance that the new line be made to conform exactly to the shape of the original line.

b. Fuel Valves. A fuel shut-off valve for each tank is provided on the crew compartment side of the bulkhead.

(1) MAINTENANCE. At the 100-hour check, remove and clean the fuel valves and strainers.

(2) REPLACEMENT OF FUEL VALVE AND STRAINER.

(a) Drain tank.

(b) Disconnect fuel line.

(c) Remove three screws.

(d) Remove valve and strainer.

(e) When replacing valve, use a new gasket and check complete job for leaks.

77. FUEL BYPASS REGULATOR VALVE (fig. 13).

a. Maintenance. If fuel bypass regulator valve fails to give proper fuel pressure, causing either too lean or too rich a fuel mixture, it should be replaced. No attempt should be made by the using arms to regulate or adjust the valve.

b. Removal of Fuel Bypass Regulator Valve (fig. 13).

WRENCH, open-end, 7/16-in. WRENCH, open-end, 15/16-in.
WRENCH, open-end, 7/8-in.

(1) Disconnect the valve inlet line (the line coming from the carburetor) at the valve (7/8-in. open-end wrench).

(2) Disconnect the valve outlet line (the return line to the fuel tanks) at the valve elbow (15/16-in. open-end wrench).

(3) Remove the U-bolt (7/16-in. wrench) that holds the valve to the bracket and remove the valve. Pull the elbow through the hole in the bracket.

c. Installation of Fuel Bypass Regulator Valve.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 15/16-in.
WRENCH, open-end, 7/8-in.

(1) Insert new valve in bracket, with outlet elbow through hole, and install and tighten the U-bolt.

(2) Connect the valve outlet line at the elbow and the valve inlet line at the front of the valve.

d. Testing Action. If engine still shows evidences of too lean a mixture (lack of power, popping, uneven running, etc.) or too rich a mixture (black smoke from exhaust), the action of the fuel bypass regulator valve should be tested with a pressure gage, and adjusted to the recommended pressure of 3¼ to 3½ pounds before trying to locate any other cause for the trouble.

78. GRADES OF ENGINE GASOLINE.

a. Gasoline, meeting AN-VV-F776, latest revision, having an octane rating of 91, is extreme for all engines without the blue name plate. Eighty octane gasoline meeting U. S. Army specification 2-103, latest revision is the standard requirement for late or modified engines carrying the blue name plate.

Section XVI

COOLING SYSTEM

Paragraph

Description 79
Inspection and maintenance 80

79. DESCRIPTION (fig. 79).

a. The engine is cooled by an air blast produced by a fan mounted on the engine flywheel. The fan draws air through a grille in the roof of the hull and forces it between and around the finned cylinders of the engine. The warm air passes out through a screen above the engine doors on the rear of the tank. Air ducts are formed on the engine by baffles bolted around and between each cylinder and cylinder head. A shroud forms a further duct for the inlet of air through the grille. A shroud in the engine compartment forces all air drawn in by the fan to pass directly around the engine cylinders.

80. INSPECTION AND MAINTENANCE.

a. At the 100-hour inspection the cooling fins on the engine cylinders and the surfaces of the shrouding and baffles will be cleaned thoroughly of all accumulated oil and dirt. All bolts on the fan ring, baffles, and fan cowling will be tightened and the fan cowling cleaned. Dirt should be cleaned from the cylinder heads, especially the lower two, at the 50-hour check. Care should be taken to see that stowage on top of the tank does not in any way interfere with the free entrance of air into the fan compartment.

COOLING SYSTEM

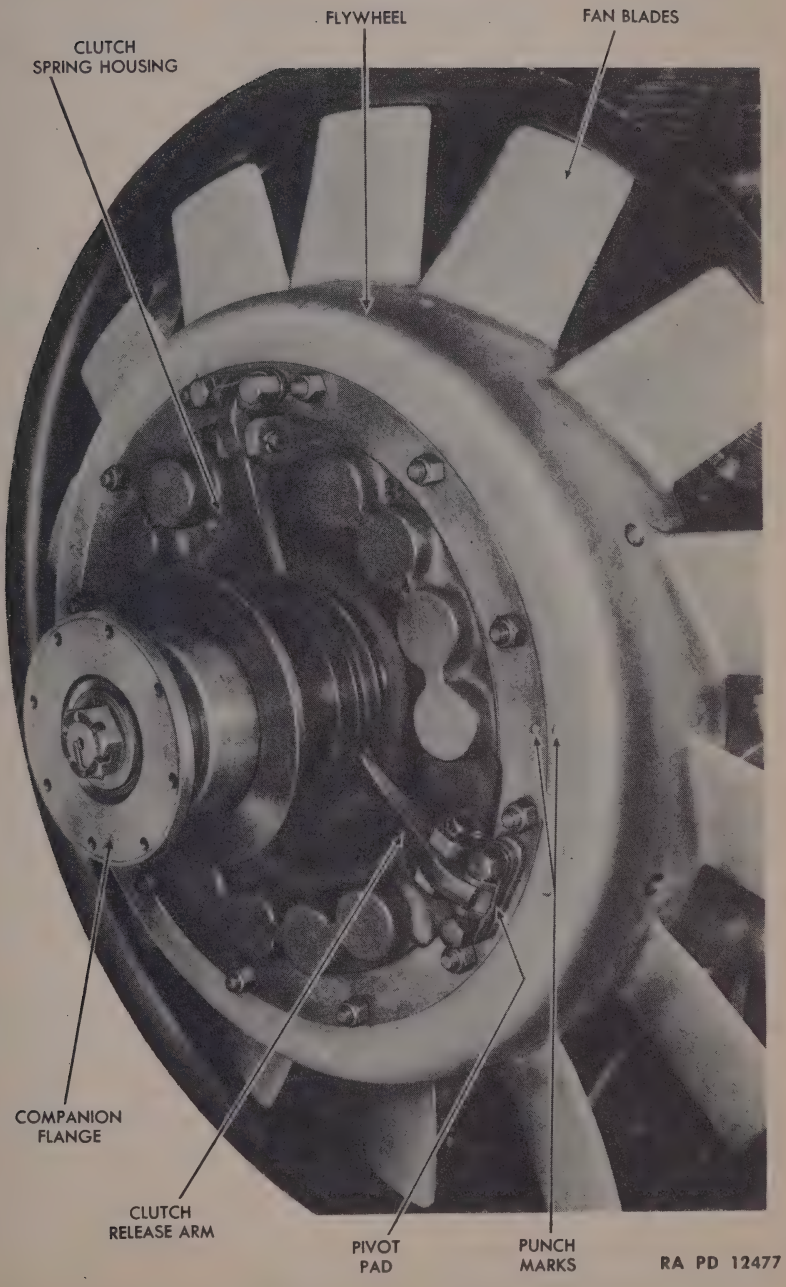

Figure 79—Clutch Installed in Flywheel

MEDIUM TANKS M4 AND M4A1

Section XVII

LUBRICATION SYSTEM

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Oil filter	85
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Engine oil tank and oil lines	87

81. GENERAL DESCRIPTION.

a. The engine lubrication system in these medium tanks depends upon the forced circulation of oil from a remote oil tank or reservoir, through the engine to the oil sump, out to the oil filter, through the engine oil cooler and back to the expansion hopper and oil reservoir (fig. 43). The amount of pressure built up in the system is determined by an oil pressure regulator valve located in the oil pump. Oil is picked up from the rear end of oil sump by means of a main scavenging pump. Because the engine tilts forward, making the front end of the sump somewhat lower than the rear end, a second or nose-scavenging pump is used to pick up the oil from this end of the sump. In some models the expansion hopper is vented to the rear of the engine by means of a breather pipe, and the nose of the engine is vented to the left lower air intake tube. In later models the engine is vented by a single breather pipe with a "hat-type" filter. This breather is located just back of the No. 1 cylinder. With this installation the engine oil tank is vented to the atmosphere.

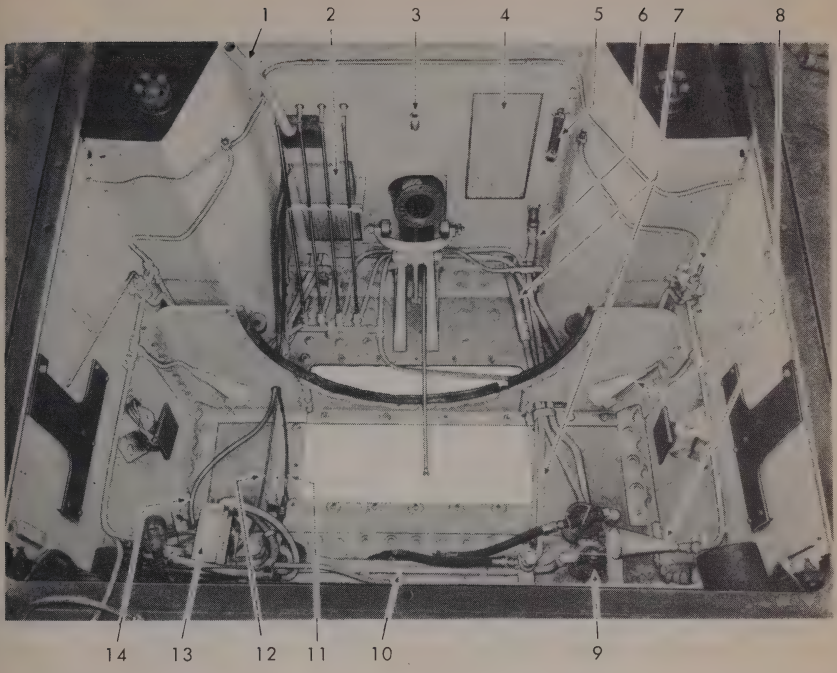
82. INSPECTIONS.

a. The entire engine lubrication system will be given continuous inspection to detect any leaks or damage to lines before they can cause loss of engine oil pressure. It is particularly important to check the proper seating of the oil temperature gage bulb, since air leaks may develop at this point. Regular inspections of the lubrication system are included in the daily 50- and 100-hour periodic inspections (pars. 26, 50 and 51).

83. TROUBLE SHOOTING.

a. Testing Oil Pump Operation (fig. 81). If no oil pressure is shown on the instrument panel gage, the action of the oil pump can be

LUBRICATION SYSTEM



1. AUXILIARY GENERATOR EXHAUST PIPE
2. TRANSMISSION OIL COOLER
3. MAIN FIRE EXTINGUISHER LINE
4. ENGINE OIL COOLER
5. OIL EXPANSION TANK BREATHER PIPE
6. OIL RETURN LINE TO COOLER
7. OUTLET LINE FROM ENGINE OIL TANK
8. FIRE EXTINGUISHER LINES AND NOZZLES
9. OIL FILTER
10. OIL RETURN LINE TO FILTER
11. OIL PRESSURE GAGE LINE AND PRIMER LINE
12. OIL TEMPERATURE GAGE LINE
13. JUNCTION BOX
14. TACHOMETER CABLE CONDUIT

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Figure 80—Interior of Engine Compartment Showing Oil Lines and Other Connections

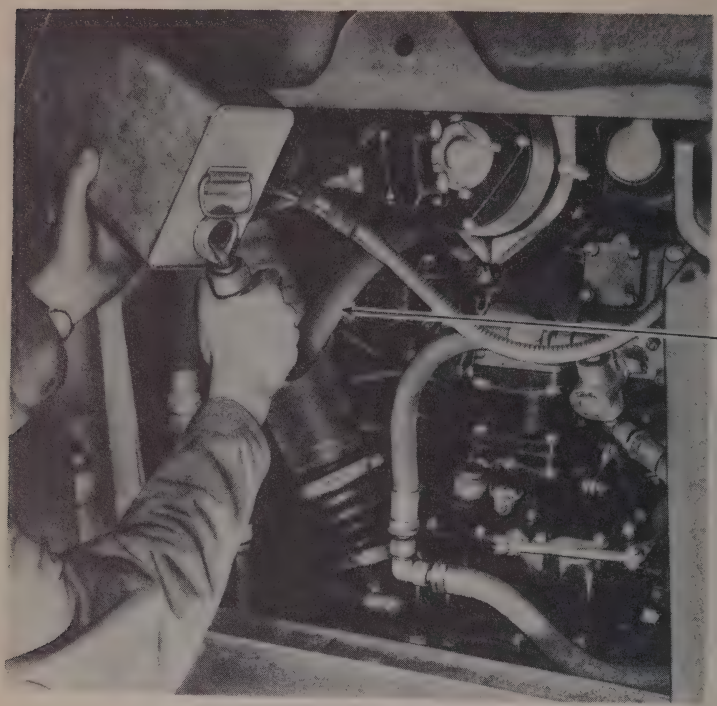

Figure 81—Priming Oil Pump Through Inlet Line

tested by disconnecting the oil inlet line at the floor of the engine compartment and priming the pump by pouring oil into the line. If the pump is operating properly, it will suck oil while the engine is being turned over with the starting motor. If no oil is drawn in, the pump should be replaced.

b. Checking the High Pressure Relief Valve (fig. 82). If the oil pump is in working order, the difficulty may be in the high pressure relief valve. To check the valve, remove it from the oil pump body and inspect it for dirt particles in the valve seat. This valve must be kept absolutely clean, since even a minute dirt particle may hold the valve open, allowing oil from the supply line to be pumped back into the return line instead of into the engine.

c. Special Precautions. Too much emphasis cannot be placed upon the importance of tightening all oil line connections and installing the oil temperature gage bulb securely, so that any possible air leak into the lubrication system is eliminated. Extreme care should be taken to prevent any dirt, sand or other foreign material from entering the lubrication system, particularly when filling the oil supply tank. The oil pressure gage on the instrument panel should be carefully watched at

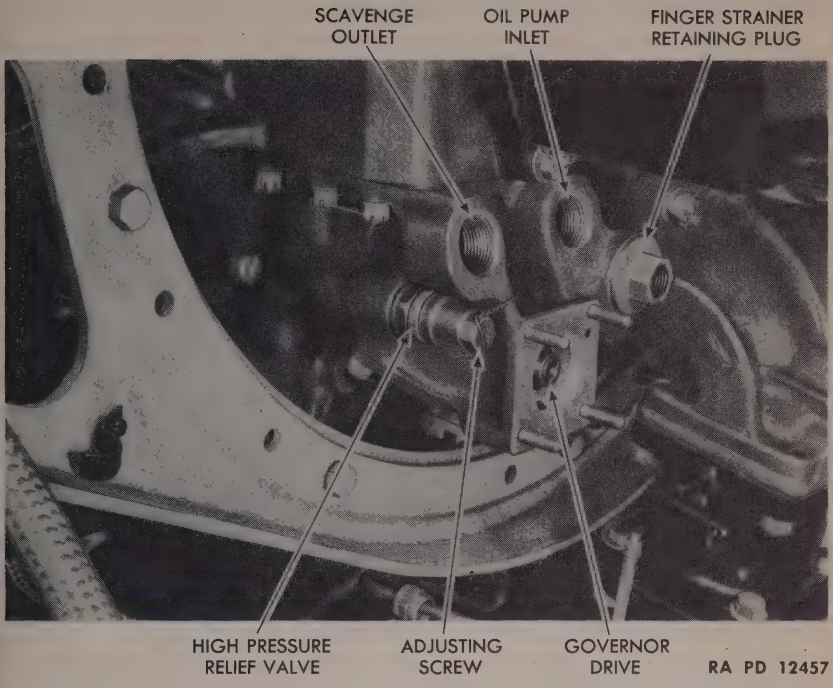

Figure 82—Engine Oil Pump (Governor Removed)

all times; and, if oil pressure is lost at any time, the engine should be stopped immediately and investigation of the failure made.

d. Reference to Engine Trouble Shooting. Because the lubrication system is so vital to engine operation much of the trouble shooting procedure in the system has been included under engine trouble shooting (par. 55).

84. OIL PUMPS (figs. 80 and 81).

a. Description. The supply of oil in the engine crankcase is maintained by an oil pump which draws oil from the engine oil tank located in the lower right-rear corner of the fighting compartment. This is a gear-type pump which is supported on the lower left side of the rear crankcase section. The pump is divided into two sections, a separate pressure pump and a main scavenger pump. In addition there is a scavenger pump located in the front section of the engine. The pressure pump draws the oil from the engine oil tank through an external line and a finger strainer into the rear section of the engine. After the oil has lubricated the internal parts of the engine, it drains off through passages into the engine oil sump located between the two bottom cylinders.

The front section scavenger pump draws the oil from the lower end of the sump. The main scavenger pump draws oil from the upper section of the sump. Both return lines join together at a "Y" connection and continue on in a single line to the oil filter.

b. Adjusting Oil Pressure. The oil pump incorporates a pressure relief valve consisting of a spring-loaded ball that rises when the desired pressure is reached and allows excess oil to be drained into the inlet side of the pump. Pressure regulation is accomplished by turning the adjusting screw clockwise to raise the pressure, and counterclockwise to lower the pressure. This raises or lowers the tension in the spring. The oil pressure should be between 60 and 80 pounds per square inch in normal operation. All possible causes for improper oil pressure should be investigated before adjusting the oil pressure.

c. Removal of Oil Pump (fig. 82).

PLIERS	WRENCH, open-end, ½-in.
PLIERS, diagonal-cutting	WRENCH, open-end, ⅝-in.
WRENCH, box, 7/16-in.	WRENCH, open-end, 1⅜-in.

(1) Disconnect the inlet at connector and outlet line at "Y" connection. Remove the inlet and outlet lines from the oil pump.

(2) Disconnect governor linkage at carburetor connection.

(3) Remove oil drain at governor.

(4) Remove the safety wire from the nuts that hold the oil pump to the accessory case and remove the nuts and plain washers (support the pump and governor with one hand while removing last nut). Remove oil pump and governor, and separate the two units. Caution must be exercised to keep foreign substances out of the crankcase during the operation.

d. Installation of Oil Pump (fig. 82).

PLIERS	WRENCH, open-end, ½-in.
PLIERS, diagonal-cutting	WRENCH, open-end, ⅝-in.
WRENCH, box, 7/16-in.	WRENCH, open-end, 1⅜-in.

(1) Assemble the oil pump to the governor and install the assembly on the crankcase.

(2) Install the retaining nuts and plain washers on the studs and secure the nuts with safety wire.

(3) Install the oil drain at the governor.

(4) Connect the governor linkage at the carburetor connection.

(5) Connect the inlet and outlet lines to the oil pump.

(6) Connect the free end of the inlet line at the connector, and the free end of the outlet line at the "Y" connection.

e. Cleaning Strainer in the Oil Pump. Remove the temperature bulb by removing the nut holding the bulb in recess. Remove strainer cover, spring, and strainer, and clean. When installing strainer, be sure that the gasket is in good condition and centered properly in its recess.

85. OIL FILTER (figs. 13 and 83).

a. Description. Lubricating oil is cleaned by means of disk-type oil filter, located in the oil return line between the scavenging pumps and the oil cooler. The oil filter is in the right rear of the engine compartment, just inside and to the right of the right engine door, directly to the rear of the fuel filter (fig. 13). The oil enters the filter body and is forced up through the filter element or cartridge. The cartridge (fig. 83) consists of a series of fine, closely spaced, metal, slotted disks, which remove the impurities as the oil is forced between them. Stationary cleaner blades, which extend between the disks, remove the accumulated dirt from the edges of the disks when the cartridge is turned by means of an external filter handle. A complete turn in either direction is called for in the daily inspection. At the 50-hour inspection the filter should be drained and flushed. At the 100-hour inspection, the filter should be removed, disassembled and cleaned (fig. 83).

b. Removal and Disassembly.

CUTTERS, diagonal
WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $1\frac{1}{8}$-in.
WRENCH, open-end, $1\frac{3}{8}$-in.

(1) Loosen the couplings on either side of the filter.

(2) Loosen the bracket that holds the filter and remove the filter.

(3) Remove the locking wire (diagonal cutters) on the 10 cap screws and, using a $\frac{7}{16}$-inch open-end wrench, remove the cap screws and washers.

(4) Remove the filter cover from the filter body and remove the gasket.

(5) Remove the locking wire on the drain plug at the bottom of the filter body with diagonal cutters.

(6) Using a $1\frac{1}{8}$-inch open-end wrench, remove the drain plug from the filter body and remove the copper washer.

c. Cleaning the Filter. After the filter is removed and disassembled, thoroughly clean the filter element, or cartridge, in SOLVENT, dry-cleaning. Flush out the filter body. CAUTION: Do not disassemble the disk assembly.

d. Reassembling and Installing the Filter.

(1) Install the copper washer and drain plug into the body and secure with locking wire.

MEDIUM TANKS M4 AND M4A1

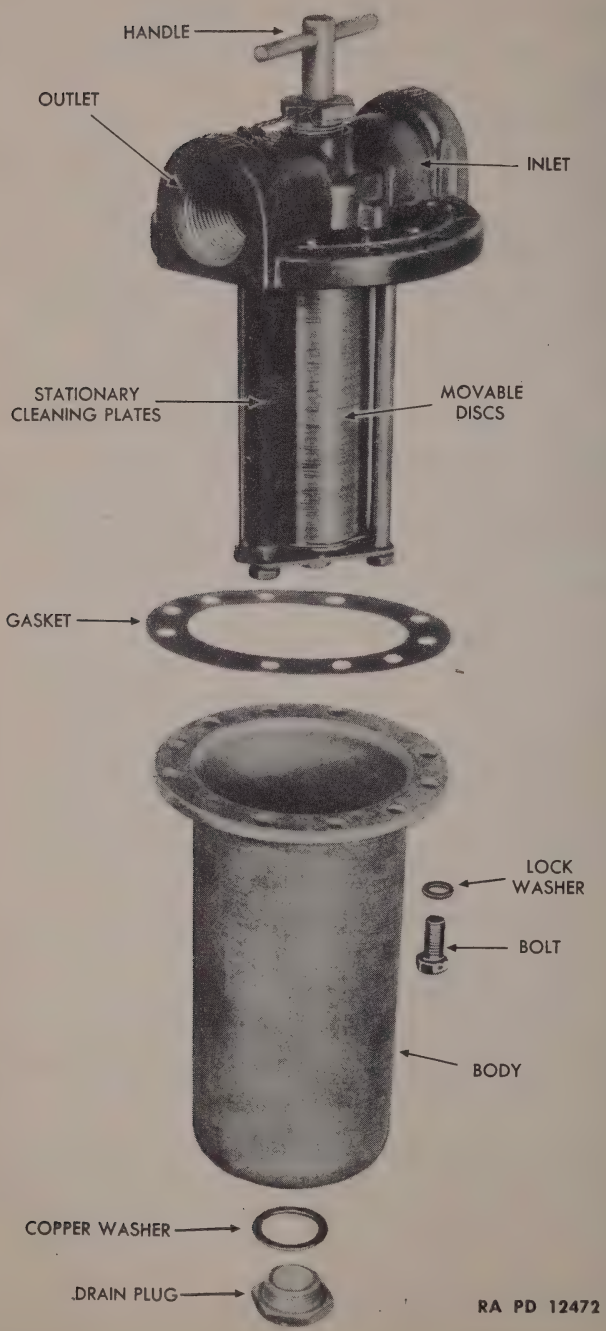

Figure 83—Component Parts of Disk-Type Filter

(2) Place a new gasket on the filter cover, assemble the body to the cover, and install and tighten the cap screws and lock washers.

(3) Secure the cap screws with locking wire.

(4) Install the filter in place and tighten the bracket.

(5) Hook up the couplings to the filter and, using a 1⅜-inch open-end wrench, tighten the couplings. NOTE: Be careful to connect the oil line from the scavenger pumps to the side of the cover marked "IN." If the connections are reversed, the filter will not function.

86. OIL COOLERS (figs. 44 and 80).

a. Description. Individual oil coolers are provided to cool engine oil and transmission oil. Oil enters at the bottom of the cooler and is forced upward through finned passages and returned to the system through the outlet pipe at the top. A spring-loaded bypass valve allows cold or thick oil to pass directly to the outlet pipe, without passing through the oil cooler passages. This occurs whenever the resistance of the oil to passing through the cooler is greater than the tension of the spring. Both oil coolers are located on the fighting compartment side of the engine bulkhead at openings which allow the passage of air through the coolers. The engine oil cooler is at the right, directly beside the engine oil tank. The transmission oil cooler is at the left, below the auxiliary generator set.

b. Maintenance. Oil coolers should be removed and thoroughly cleaned at every 100-hour inspection. Interior oil passages should be flushed, fins and air passages blown out with compressed air, and the bypass valve removed, cleaned, and its operation checked.

c. Removal of Oil Cooler.

WRENCH, 7/16-in.
WRENCH, crescent, 2¼-in.
WRENCH, open-end, 1⅜-in. or WRENCH, adjustable, 10-in.

(1) Remove the four cap screws (7/16-in. wrench) that hold the cooler guard to the bulkhead, and remove the guard.

(2) Disconnect the cooler inlet line at the base and the outlet line at the top of the cooler (1⅜-in. open-end wrench or 10-in. adjustable wrench). NOTE: When removing the engine oil cooler, the elbow on the cooler inlet line can be removed only from the engine compartment side of the bulkhead. This should be done with the engine out of the tank. In removing the elbow be sure to hold the fitting sweated to the cooler (2¼-in. crescent wrench) to avoid damage to the fitting.

(3) Remove the two cap screws (7/16-in. wrench) from the upper and lower brackets, removing the brackets and sliding the cooler around and up, and out through the opening in the turret basket.

d. Installation of Oil Cooler.

(1) Slide oil cooler into place, first inspecting felt buffer strip on retaining channel and replacing if needed.

(2) Install and tighten the upper and lower brackets, securing the cooler in place.

(3) Connect the cooler inlet and outlet lines. If installing the engine cooler, the inlet line and elbow must be connected from the engine compartment side of the bulkhead.

(4) Install and tighten the oil cooler guard in position on the bulkhead.

87. ENGINE OIL TANK AND OIL LINES (figs. 44 and 80).

a. General. The oil tank can be replaced only when the engine is out of the vehicle. It is regularly removed, flushed and reinstalled at the 100-hour inspection. The oil lines should be blown free of sediment at the 100-hour inspection.

b. Removal of Oil Tank.

SCREWDRIVER	WRENCH, open-end, 1-in.
WRENCH, Allen, 9/16-in.	WRENCH, open-end, 1 3/8-in.
WRENCH, open-end, 9/16-in.	WRENCH, open-end, 1 3/4-in.

(1) Drain the tank by removing the drain plug plate and gasket from the floor of the hull (screwdriver) and removing the drain plug (9/16-in. Allen wrench). Catch the oil (about 36 qts) in an open container.

(2) Remove the four fillister-head bolts that hold the legs of the tank to the vehicle floor. A man beneath vehicle turns bolts out with screwdriver while man in vehicle holds the nuts from turning (9/16-in. open-end wrench).

(3) Disconnect the oil tank return line at the cooler elbow (1 3/8-in. open-end wrench). CAUTION: If the connection is tight it may be advisable to protect the elbow by bracing it with a 1 3/4-inch open-end wrench (fig. 44).

(4) Disconnect the breather line from the expansion hopper (1-in. open-end wrench) and pull the breather line forward through the bulkhead. With engine removed, the engine end of the line will be free.

(5) Disconnect the oil outlet line from the tank by disconnecting the flexible coupling (1 3/8-in. open-end wrench) in the engine compartment (fig. 80). CAUTION: Do not attempt to disconnect the outlet line at the bottom of the tank before the tank is removed from the vehicle.

(6) Remove the tank, pulling the outlet line forward through the bulkhead, then bringing the tank up through the trap door in the turret

basket floor and out through the turret hatch. NOTE: To avoid spilling oil in the turret during removal of the tank, replace the drain plug in the bottom of the tank before starting to remove it.

c. Installation of Oil Tank.

OIL, engine, seasonal grade
SCREWDRIVER
WRENCH, Allen, 9/16-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 3/8-in.

(1) With the drain plug in place, install the tank on the floor of the hull with the inlet line flexible coupling projecting through the bulkhead opening into the engine compartment.

(2) Connect the oil inlet line by hooking up and tightening at the flexible coupling (fig. 80) in the engine compartment (1 3/8-in. open-end wrench).

(3) Connect the breather line at the expansion hopper and tighten with a 1-inch open-end wrench (fig. 44).

(4) Connect the return line at the cooler elbow and tighten with a 1 3/8-inch open-end wrench.

(5) Install the four fillister-head bolts that hold the legs of the tank to the floor (screwdriver and 9/16-inch open-end wrench).

(6) Tighten drain plug (9/16-inch Allen wrench) and install a new gasket and the drain plug plate to the floor of the hull (screwdriver).

(7) Refill the engine oil tank with clean engine oil of the amount and grade specified in the War Department lubrication guide (fig. 40).

d. Replacement of Oil Lines. Replace the oil lines when they are dented, punctured or damaged so that the free flow of oil is impaired. To replace the oil lines unscrew the correctors from the ends of the lines. When installing the new oil line make sure that the line conforms to the shape of the old one.

Section XVIII

CLUTCH

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Care	90
Pedal adjustment	91
Removal of clutch	92
Inspection of clutch	93
Installation of clutch assembly	94
Major clutch adjustment	95

88. DESCRIPTION (fig. 84).

a. The clutch serves as a means of engaging the engine to and disengaging the engine from the propeller shaft and the power train, which consists of transmission, differential, final drives, and sprockets. The clutch is built into the engine flywheel and is located in the front of the engine.

89. OPERATION.

a. The clutch allows the engine to pick up load gradually after shifting gears. When the clutch is engaged, the springs inside the clutch housing exert their full pressure against the clutch plates, enabling the engine power to go through to the propeller shaft. When the clutch pedal is depressed, the pressure plate is pulled back from the clutch plates, compressing the clutch springs, allowing the clutch plates to rotate free of the propeller shaft. Engine power is thus prevented from going through to the propeller shaft.

90. CARE.

a. Clutch outer hub bearing is greased as prescribed in the lubrication section VI. Clutch is disassembled and cleaned at each 100-hour inspection (par. 92).

91. PEDAL ADJUSTMENT (figs. 16, 17 and 18).

a. As the clutch facing wears, the amount of pedal free play is reduced, and, in time, this will result in clutch slippage due to lack of clearance at the release bearings. It is, therefore, necessary to check pedal free play every day and to adjust if the play is less than one inch. Correct adjustment of the clutch pedal is made by lengthening or shortening the adjusting link (par. 7), depending on whether there is too

Figure 84—Flywheel, and Clutch Disassembled

little or too much clearance (fig. 18). The clutch pedal linkage is properly adjusted when there is ⅛-inch clearance between the release bearings and the front flange of the sliding sleeve with the clutch engaged (figs. 16 and 17). This should result in approximately one-inch free play of the clutch pedal.

92. REMOVAL OF CLUTCH (figs. 46, 79 and 84).

a. Equipment.

PLIERS
PLIERS, diagonal-cutting
WRENCH, socket, ¾-in., with hinge handle
WRENCH, socket, heavy-duty, $1\frac{13}{16}$-in., with sliding "T" handle

b. Procedure.

(1) REMOVING THE COMPANION FLANGE (fig. 84).

PLIERS, diagonal-cutting
WRENCH, socket, heavy-duty, $1\frac{13}{16}$-in.

(a) Using the cutting pliers, remove the cotter pin from the clutch spindle nut (fig. 84).

(b) With the $1\frac{13}{16}$-inch heavy-duty, socket wrench, remove the nut and then remove the flat washer.

(c) Pull out the companion flange.

(2) REMOVING THE CLUTCH SPRING HOUSING (fig. 79).

PLIERS
WRENCH, socket, ¾-in.

(a) Using pliers, remove the locking wire from the cap screws that hold the pivot pads to the housing.

(b) Using a ¾-inch socket wrench, remove the cap screws and the 12 nuts that hold the shim pads and cover to the flywheel.

(c) Lift out the clutch spring housing assembly. The spindle will come out with the clutch spring housing. NOTE: If housing and flywheel are not already punch marked, mark both parts before removing spring housing to assure proper alinement in reassembly (fig. 79).

(3) REMOVING THE CLUTCH PLATES. The driving and driven plates can now be lifted out.

93. INSPECTION OF CLUTCH (fig. 46).

a. Clean the clutch plates and examine them for glazing, warpage, cracks, scoring, and worn or damaged linings (fig. 46). Replace any defective plates. Return plates with faulty linings to ordnance for installation of new linings. Inspect the inner and outer bearings for wear. Inspect bearing races for pitting or wear. If it is found that bearings need replacing, notify ordnance maintenance personnel. Clean flywheel and inspect for worn or damaged lining, cracks, or other damage.

CLUTCH

94. INSTALLATION OF CLUTCH ASSEMBLY.

a. Equipment.

DRIFT, brass
HAMMER
PLIERS
SCREWDRIVER
WRENCH, socket, ¾-in.
WRENCH, socket, heavy-duty, $1\frac{13}{16}$-in.

b. Procedure.

(1) INSTALLING SPINDLE. Remove the locking screws from teeth on the spindle, and slide the spindle into place over the flywheel hub, driving it all the way home before installing the plates.

(2) INSTALLING PLATES. Install the plates, being careful to keep them in the same order in which they were removed. Reinstall the locking screws and locking wire. CAUTION: Do not allow the spindle to be moved forward after the plates are installed or the inside plate will drop down behind the spindle and necessitate starting over again.

(3) INSTALLING COVER. Slide the clutch spring housing and cover into place on the spindle, being sure that punch marks on the flywheel and on the cover are lined up (fig. 79). Drive cover into place with a brass drift and hammer. Install and tighten the self-locking nuts that hold the cover to the flywheel. Insert the shims under the pivot pads and install the special cap screws holding the pads to the flywheel.

(4) INSTALLING THE COMPANION FLANGE. Slide the companion flange into place in the clutch cover hub, being careful not to injure or turn back the tips of the grease seal in the hub. If any difficulty is experienced in entering the companion flange through the seal, use shim stock to protect the seal. Install and tighten the flat washer and hub nut, securing the nut with a new cotter pin.

95. MAJOR CLUTCH ADJUSTMENT (fig. 79).

a. Introduction.

Clutch slippage due to wear of the clutch plates can be eliminated by a major clutch adjustment, which involves removing a shim from under each clutch release arm pivot pad. Although a worn clutch always should be replaced with a new one, conditions may be such in the event of an emergency that a new clutch is not available. In this case, and in this case only, a major clutch adjustment should be made.

b. Adjustment.

PLIERS
WRENCH, socket, ¾-in., with universal extension and handle

(1) Disconnect the clutch linkage at the forward end of the short, adjustable rod by taking out the cotter pin (pliers) and removing the clevis pin.

(2) Open the air inlet cover.

(3) Remove the locking wire on the pivot pads (pliers) and, using a ¾-inch socket wrench with universal extension and handle, remove the two cap screws from each of the pads. All the pivot pads can be reached by turning the engine over with the crank.

(4) Remove one shim from each pad. There are usually five shims of about 0.025 inch each, under each pad.

(5) Replace the cap screws and the locking wire.

(6) Adjust the linkage at the short adjustable rod so that there is ⅛-inch clearance between the clutch release bearings and the forward flange of the sliding sleeve.

(7) Connect the linkage.

(8) Close the air inlet cover.

Section XIX

PROPELLER SHAFT

	Paragraph
Description	96
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Removal of propeller shaft	99
Installation of propeller shaft	100

96. DESCRIPTION (figs. 85 and 86).

a. The propeller shaft transmits power from the clutch to the input shaft of the transmission. It is equipped with two universal joints, one at each end, which permit operation at an angle with the transmission and the clutch. A slip joint near the forward end permits lengthening and shortening of the shaft. This joint also facilitates removing or replacing the propeller shaft in the tank and the installation of the engine. The propeller shaft is enclosed in a "tunnel" housing in the center of the floor of the crew compartment.

97. INSPECTIONS (figs. 85 and 86).

a. Following are the inspections that should be made on the propeller shaft.

(1) The universal joints should be inspected during the 25- and 100-hour inspections to determine whether the bearings and cups are worn. Symptoms of wear on these parts are excess vibration and noise while the shaft is in motion. Worn bearings will necessitate the replacement of the shaft.

(2) Inspection should be made for leaking grease seals, which will be shown by streaks of lubricant on the universal joint covers of the housing. Leaky seals should be replaced. This will require separation of the slip joint (par. 99 **b**).

(3) With the engine stopped, the shaft should be tested for looseness, and the bolts on the companion flange checked for tightness and tightened if necessary.

98. LUBRICATION.

a. The universal joints and the slip joint should be lubricated as prescribed in the lubrication guide (fig. 40). Note that the universal joints should be repacked every 300 hours.

99. REMOVAL OF PROPELLER SHAFT (figs. 85 and 86).

NOTE: Before the propeller shaft can be removed, the engine must be out of the tank (par. 56).

Figure 85—Propeller Shaft with Slip Joint Removed

PROPELLER SHAFT

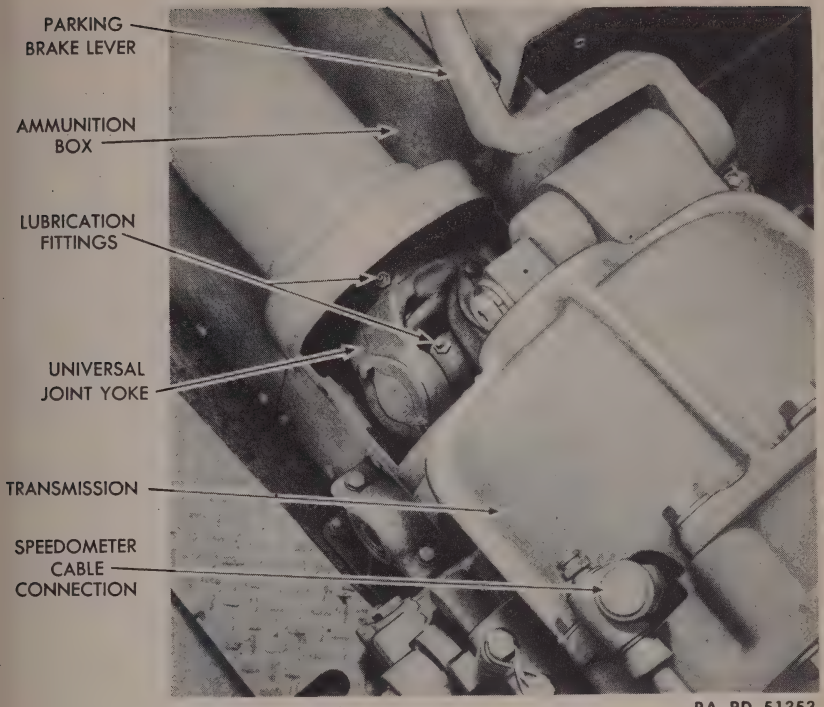

Figure 86—Front Universal Joint with Cover Removed

a. Equipment.

WRENCH, open-end, $\frac{7}{16}$-in. WRENCH, open-end, $\frac{9}{16}$-in. (2)

b. Procedure for Removal.

(1) Remove the front and rear universal joint covers and the slip joint cover at the front left side of the propeller shaft tunnel ($\frac{7}{16}$-in. open-end wrench). NOTE: It will be necessary to move the ammunition box before the slip joint cover can be removed.

(2) Unscrew the dust cap and disconnect the slip joint by pulling the propeller shaft out through the rear of the tank. CAUTION: Before disconnecting at the slip joint, it is important to note whether there are alinement arrows on the front and rear sections of the slip joint. If there are none, these sections should be marked so that they can be lined up properly when reassembled.

(3) Remove the front companion flange bolts, using two $\frac{9}{16}$-inch open-end wrenches.

(4) Lift out the front universal joint.

100. INSTALLATION OF PROPELLER SHAFT.

a. Equipment.

WRENCH, open-end, $^{7}/_{16}$-in.
WRENCH, open-end, $^{9}/_{16}$-in. (2)

b. Procedure.

(1) Slide propeller shaft into place, being sure the dust cap, split washer, and oil seal are in place.

(2) Lift the front end of the shaft and slide the slip joint hub into place over the splines of the stub shaft, so that the alinement marks on the propeller shaft and on the slip joint hub are exactly in line. NOTE: If on disassembly of the propeller shaft there are no arrows on the front and rear sections of the slip joint and no marks were made as suggested in step **b** (2), the propeller shaft can be alined properly on the reassembly by joining the front and rear sections of the slip joint in such a position that the yokes on the front and rear universal joints lie in the same plane. It is extremely important that the slip joint sections be alined properly, as a vibration of the propeller shaft will result if the universal joints are out of alinement.

(3) Screw the dust cap into place by hand.

(4) Line up the holes of the front companion flange with those on the transmission rear flange and intall and tighten the bolts and lock washers.

Section XX

POWER TRAIN

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101. DESCRIPTION (fig. 87).

Power in the tank is transmitted from the propeller shaft to the tracks by means of the power train, which consists of the transmission, controlled differential, final drives and sprockets.

102. TRANSMISSION.

a. General. The transmission has five forward speeds and one reverse speed. Its second, third, fourth, and fifth gears are synchronized to permit easier shifting, and its first and reverse gears are constant mesh. A parking brake, which acts on the output shaft, is built into the transmission, and is operated by a lever to the right and behind the driver. This brake will be used only after the vehicle has been brought to a stop.

b. Replacement of Gear Shift Lever.

(1) REMOVAL.

HAMMER
PLIERS
PUNCH, ½-in.
WRENCH, open-end, ¾-in.
WRENCH, open-end, ⅞-in.

Remove cotter pin (pliers) from nut on right side of wear shift lever shaft and remove nut (⅞-in. open-end wrench) and washer. Drive out shaft (punch and hammer) and lift out gear shift lever and yoke. Remove cotter pin (pliers) and nut (¾-in. open-end wrench) from yoke pin and drive out pin, after which the gear shift lever can be removed.

(2) INSTALLATION.

HAMMER
PLIERS
PUNCH, ½-in.
WRENCH, open-end, ¾-in.
WRENCH, open-end, ⅞-in.

Install yoke pin and secure with nut (¾-in. open-end wrench) and

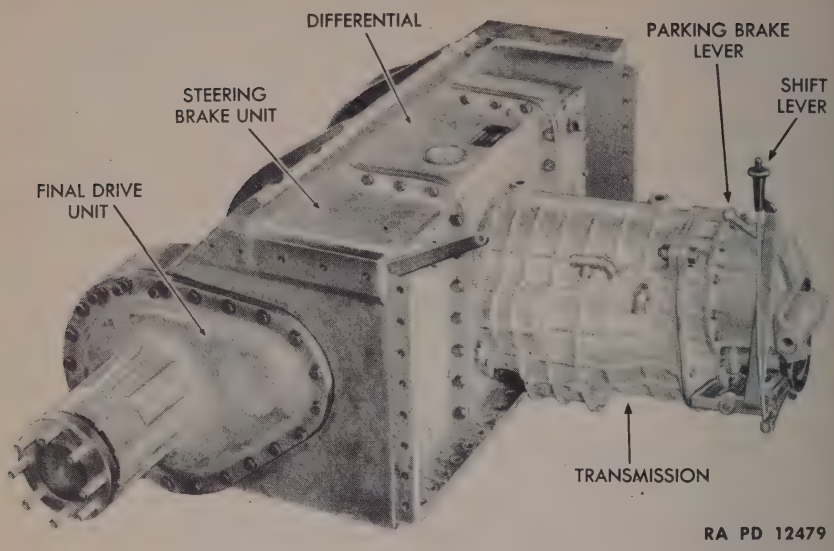


Figure 87—Power Train

cotter pin. Install gear shift lever and yoke assembly in position and drive shaft into place. Secure with nut (⅞-in. open-end wrench), washer and cotter pin.

103. DIFFERENTIAL.

a. The differential is called a "controlled differential" because it serves not only to transmit engine power to the final drive units, but it also has a brake drum on each side of the differential housing for the purpose of steering and stopping the tank. The differential is so designed that when the speed of one brake drum is reduced, the speed of the other is increased.

104. LUBRICATION OF TRANSMISSION AND DIFFERENTIAL.

a. The transmission, together with the controlled differential, contains 64 quarts of oil, which is circulated by a small pump built into the transmission case and driven off the rear end of the reverse shaft. Oil is added, and the level is checked, by the removal of a filler cap which is located to the right and to the rear of the transmission. A bayonet-type oil gage is built into the cap. The level of oil will be checked at the end of each day's run, and additions will be made to keep the level up to the full mark. Oil as specified on the lubrication guide (fig. 40) is to be used. The transmission and controlled differential oil will be drained at intervals, as indicated in the lubrication

guide, by the removal of a plug in the bottom of the controlled differential case. This plug is reached from underneath the tank.

105. STEERING BRAKES.

a. Description (fig. 88). The controlled differential, which incorporates the device for steering the tank, contains two "halves", each of which is separately controlled by a brake drum and brake shoe. When one brake is applied, one-half of the differential slows down while the other half speeds up. By this means, the vehicle is steered. It is impossible to lock one final drive sprocket as long as the other sprocket is in motion. The vehicle will stop only with both the brake bands contracted.

b. Adjusting Steering Brakes (fig. 89).

RULE, 6-in.
STRAIGHTEDGE
WRENCH, deep-socket, 1⅛-in.
WRENCH, adjustable large

(1) With a large, adjustable wrench, remove the brake adjusting hole plugs from each inspection plate. Turn the adjustment nut until it is flush with the end of the stud (1⅛-in. deep-socket wrench.)

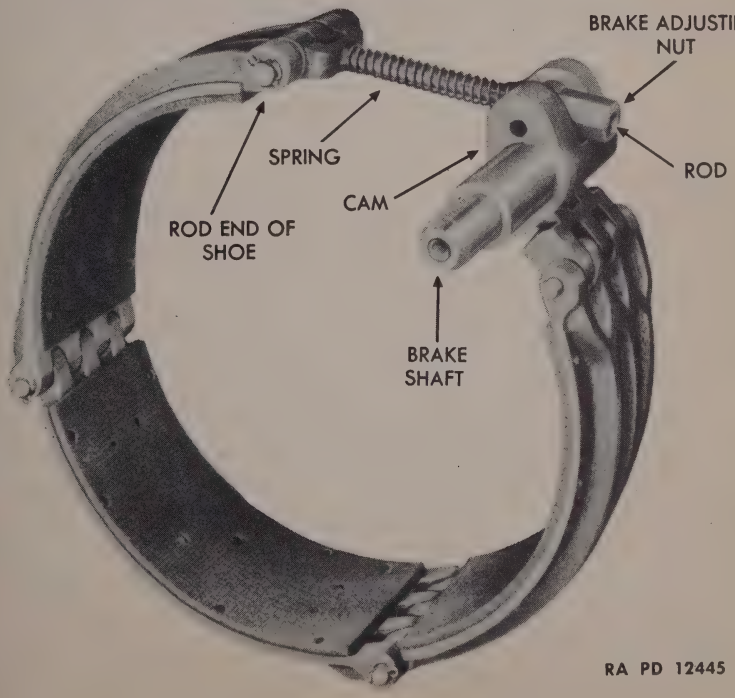


Figure 88—Detail of Brake Band

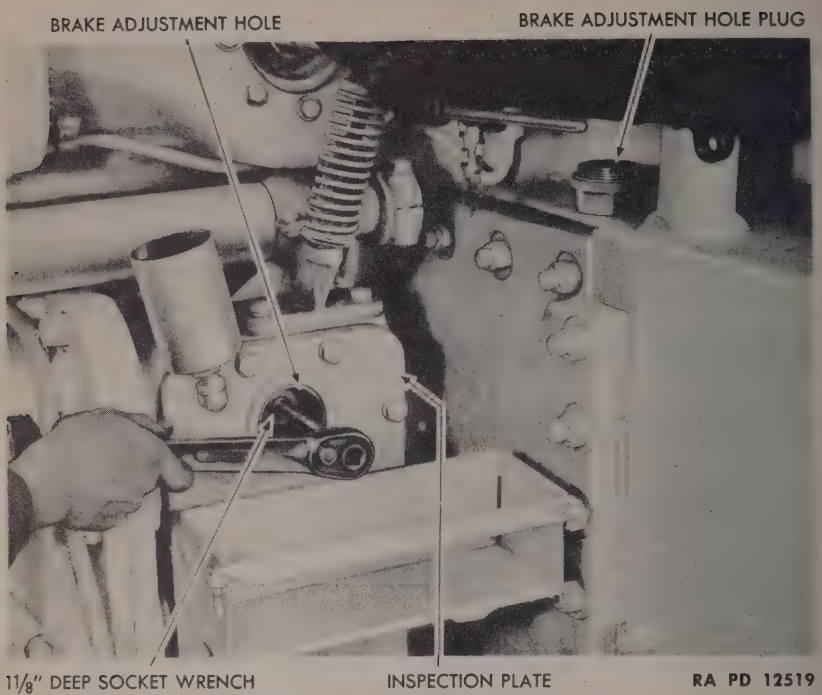


Figure 89—Adjusting Steering Brake

(2) Check the position of the brake shafts. With the brake shoes properly installed, the mark on the shaft ends will be vertical.

(3) With the brakes in the "OFF" position, measure the distance from the top of the left brake assembly housing to the top of the left brake arm. This measurement is taken with a straightedge placed along the top of the housing even with the cover plate, and a rule measuring the distance vertically from the straightedge to the brake arm. The distance should be as near to 2¾ inches as the position of the serrations on the shaft will allow. Any great deviation from this measurement will decrease the steering leverage. If the arm position is incorrect, loosen the clamping bolts on the arm, slide it off and reinstall it on the shaft on the serration, bringing the arm to the point closest to the required measurement. NOTE: If new shoes are being installed, the steering lever linkages will have to be disconnected at the brake arm. If nearly an adjustment of brakes is being made, it will be necessary to break the linkages at the brake arms before making any change in the position of the arm on the shaft.

(4) When the right brake arm is installed with the linkage toward

the rear, the arm position should be the same as the left brake arm. On transmissions having the linkage toward the front, check the position as follows: Measure the distance from the top of the right brake assembly housing to the outer end of the right brake arm (just above the pin) using a straightedge and 6-inch rule (or flexible steel rule). The distance should be as near to 3½ inches as the position of the serrations will allow. If necessary to change the position of the arm, disconnect the linkage to the cross shaft, relocate the arm, and readjust and reconnect the linkage.

(5) Back off the brake adjusting nut about four full turns (1⅛-in. deep-socket wrench), loosening the bands. CAUTION: Care should be used in removing the 1⅛-inch socket wrench to make sure that the socket does not come loose from the handle and drop down into the housing.

(6) Set the steering lever stops so that the levers are even with each other and parallel with the linkage rods when against the stops.

(7) Connect up the linkage at the arms, changing the position of the clevises, if necessary, to allow the steering levers to rest against the stops when the arms are in the correct position.

(8) Tighten each brake adjusting nut so that the band makes full contact with the drum after 5½ inches of steering lever travel, measured at the top of the steering lever. With less than this amount of free travel the bands will ride on the drums, causing heating and wear. More than this amount of free travel reduces the total amount of breaking available.

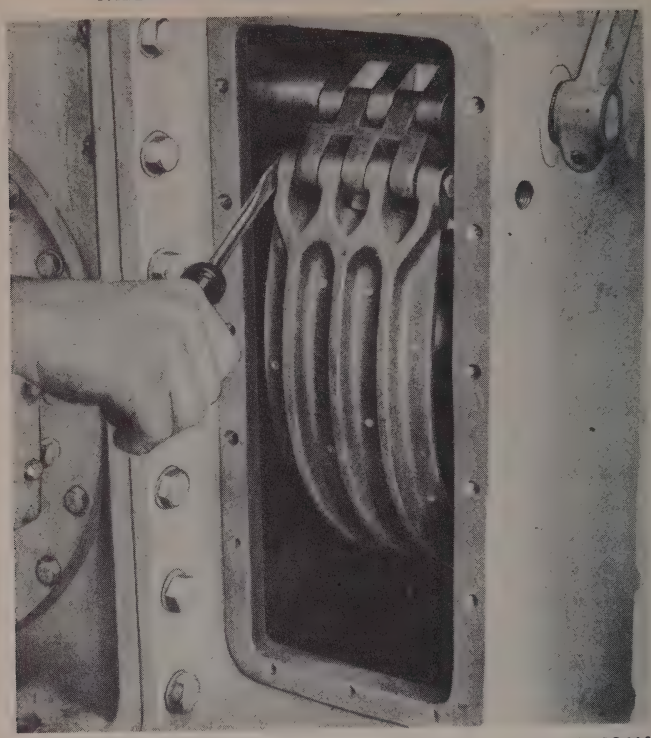
c. Removal of Brake Shoes for Relining (figs. 90 and 91).

BAR, pinch
PLIERS
WRENCH, deep-socket, 1⅛-in.
WRENCH, open-end, ⅞-in.
WRENCH, open-end, 1 3/16-in.
WRENCH, socket, ¾-in.

(1) Opening the Housing. Drain the oil from the differential. Remove the bolts (¾-in. socket wrench) from the brake inspection plate and remove the plate. It will be necessary to remove the ammunition rack from the right housing. To simplify operations, the breathers should be turned out of the housing also.

(2) Breaking the Steering Linkages. Break the steering linkages at the brake arms by removing the cotter pins and clevis pins.

(3) Disconnecting the Brake Shoes. If possible, turn down the centering bolt beneath the shoe (⅞-in. open-end wrench) to prevent brake shoe hinges from catching on the bolt. Remove the cotter pin from the differential end of the link pin holding the brake shoe to the bottom



RA PD 12461

Figure 90—Disconnecting Brake Band from Link

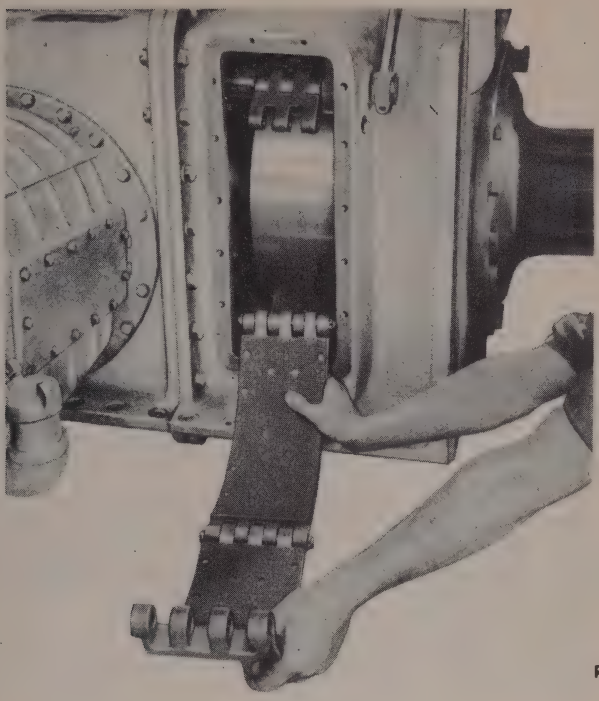
end of the 5-pronged link. Remove the plug in the side of the steering drum housing ($1\frac{3}{16}$-in. open-end wrench) and remove the link pin out through the plug opening (fig. 90). Remove the brake adjusting nut ($1\frac{1}{8}$-in. deep-socket wrench) holding the adjusting stud in place with the hand. Shove the stud forward, securing the spring and washer on a screwdriver or drift. Both ends of the brake shoes are now free.

(4) Removing the Brake Shoes. Using a pinch bar to aid in working the brake shoes out, remove the shoes around the bottom of the drum (fig. 91). Care must be taken to work the hinge sections over the centering bolt.

d. Installation of New or Relined Brake Shoes.

PLIERS
WRENCH, open-end, $1\frac{3}{16}$-in.
WRENCH, open-end, $\frac{7}{8}$-in.

(1) Installing the Brake Shoes. Push the rod end of the brake shoes up behind the brake drum until it can be reached from the top. A wire fastened to the end of the shoe and pulled tight around the drum will help hold the shoes away from the centering bolt. Insert the washer



RA PD 12468

Figure 91—Pulling Brake Band Out from Below Drum

and spring over the rod and insert the rod through the cross arm in the upper cam section, holding it in place with the adjusting nut. Bring the other end of the shoes around the front of the drum to the link. Insert the link pin through the plug opening in the housing, and lining up the holes in the link and the shoe, insert the link pin to connect the shoe to the link. Install and secure the cotter pin.

(2) CLOSING THE HOUSING. Replace the plug in the housing ($1\frac{3}{16}$-in. open-end wrench). If the centering bolt was turned down, turn it up ($\frac{7}{8}$-in. open-end wrench) until it is tight, and back it off one full turn. This will give the proper clearance at the bottom of the shoes. Replace the inspection plate, installing a new gasket. Replace the ammunition rack and the breathers.

(3) Adjust the brake shoes (par. 105 b).

e. Removing Steering Levers (fig. 92).

HAMMER
PLIERS
SCREWDRIVER

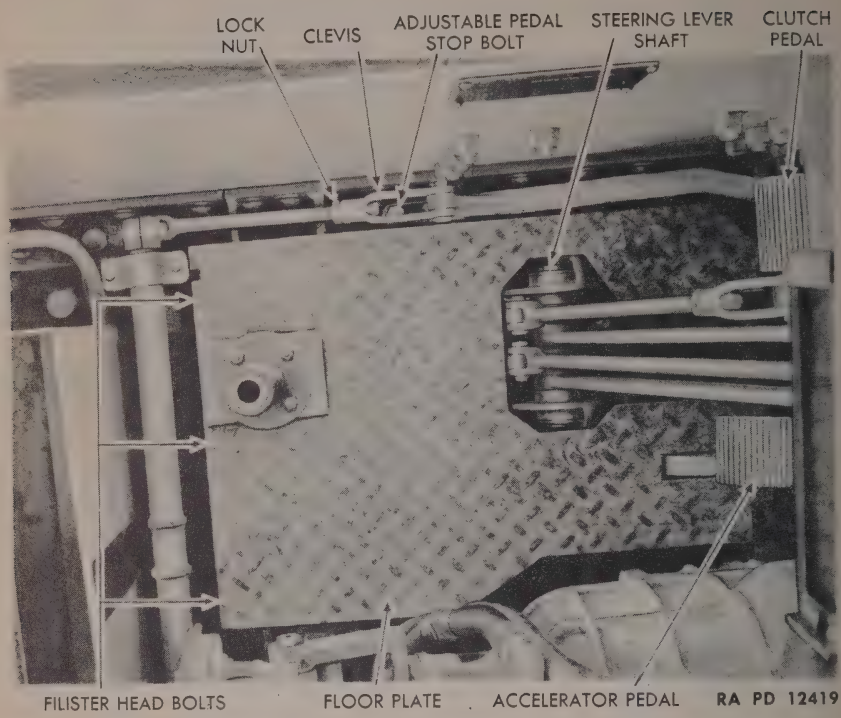


Figure 92—Detail of Clutch Pedal and Steering Lever Linkages

(1) Remove driver's seat by pulling out locking pin and lifting seat from base.

(2) Remove the subfloor by removing the eight fillister-head bolts and lifting the floor up out of the way.

(3) Remove cotter pin from left end of steering lever shaft and drive shaft out towards transmission.

(4) Disconnect the damaged lever or levers by removing the cotter pin and the clevis pin from the clevis at the bottom of the adjustable rod.

f. Installing Steering Levers.

HAMMER SCREWDRIVER
PLIERS

(1) Set lever, or levers, in place and connect clevis on adjustable rod to steering lever by installing clevis pin and securing with cotter pin.

(2) Line up levers and tap shaft through into place. Secure with cotter pin.

(3) If necessary, adjust stops on levers so that they will be parallel

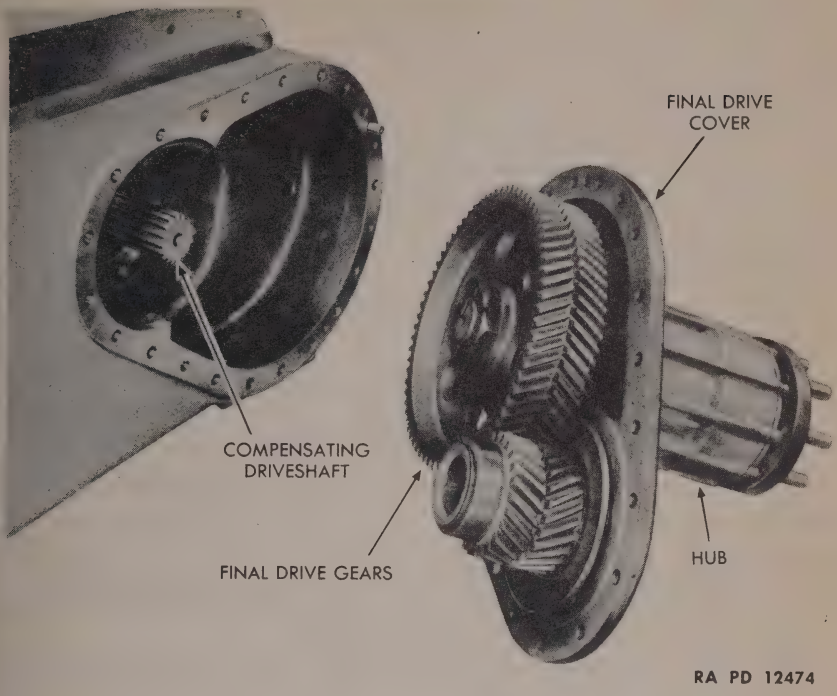


Figure 93—Final Drive Removed from Power Train

with the adjustable rods and against the stops when brake shaft arms are in proper position (par. 105 **b** (2)).

(4) Replace subfloor and secure with bolts.

(5) Replace driver's seat.

106. FINAL DRIVES.

a. Descripiton (fig. 93). The final drives transmit power from the differential to the hubs of the driving sprockets. Each has a set of reduction gears, through which the power is transmitted from the final drive shaft to the sprocket shaft. Each set of final drive gears is mounted on a cover bolted to a final drive housing. A driving sprocket is bolted to a hub on each final drive cover.

b. Lubrication (figs. 40 and 41). The final drives are lubricated by separate quantities of 36 quarts of oil for each final drive housing. The oil level is checked through plug holes on the sides of the final drive housings. The oil level should be ½-inch below the bottom of the plug hole. The level of the oil will be checked and oil of the specified grade

(as shown on the lubrication guide (fig. 40) will be added to maintain the proper level. Oil may be added at the filler plugs outside the tank in the final drive housing. The oil in the final drives will be drained at intervals as indicated in the lubrication guide. The drain plugs are located on the outside of the tank in the bottom of each final drive housing. Thirty-six quarts of oil of the grade shown on the lubrication guide will be required for refilling each final drive. NOTE: Always check oil in either final drives or transmission after the tank has stood for several hours. Never check the oil immediately after running the tank as it may be hot and foaming and will not give an accurate reading. When checking oil, be sure the tank is on level ground.

c. Removal of Final Drive Unit (fig. 93).

(1) Drain the oil from the final drive.

(2) Remove the sprockets as outlined in par. 107 **b**.

(3) Remove the 22 cap screws that secure the final drive unit to the final drive housing.

d. Installation of Final Drive.

(1) Withdraw the final drive unit, using a final drive lifter or hoist.

(2) Install a new final drive unit in place.

(3) Install dowels and the 22 cap screws that secure the final drive unit to the final drive housing.

(4) Install the sprockets (par. 107 **c**).

(5) Refill the final drive with oil.

107. DRIVE SPROCKETS.

a. Description. Each track drive sprocket assembly is made up of two toothed plates, bolted to a sprocket hub, which, in turn, is bolted to the flanged end of the final drive sprocket shaft. The right and left drive sprockets are interchangeable.

b. Maintenance. Inspect the sprockets frequently to insure that tooth-plate bolts and hub bolts are sufficiently tight. When appreciable wear is noted on the sprocket teeth, interchange the right and left sprockets to bring the track in contact with the unused area of the teeth.

c. Removal and Installation.

(1) Slacken and disconnect the track below the sprocket (par. 108 **b** (6)).

(2) Remove the eight hub retaining nuts.

(3) Remove the sprocket assembly.

(4) To install set the sprocket assembly in place.

(5) Install the eight hub retaining nuts.

(6) Hook up and tighten the track (par. 112 **b**).

POWER TRAIN

108. REMOVAL OF POWER TRAIN.

a. Equipment.

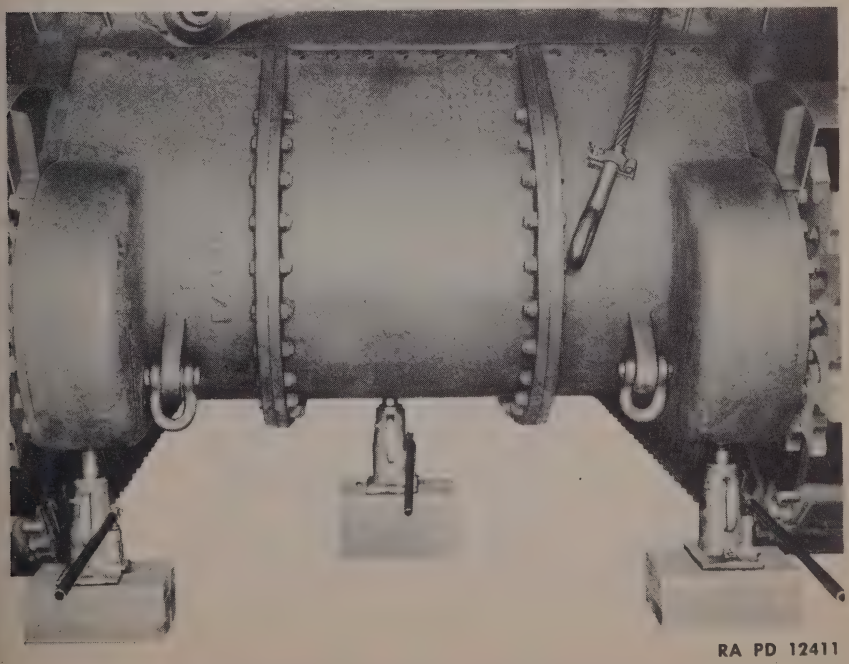
BAR, track, 27-in.
BLOCKING
CABLE (2)
CHAIN (2)
EXTENSION, 12-in.
HANDLE, heavy-duty ratchet
HAMMER
HAMMER, sledge
JACK, 10-ton (3)
PLIERS, 8-in.
PLIERS, cutting
PUNCH, 1/4-in.
SCREWDRIVER
SOCKET, 1 1/8-in.
TANK, second or wrecker
WRENCH, 7/16-in.
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 11/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 1 1/8-in.
WRENCH, open-end, 1 3/8-in. (2)
WRENCH, socket, 1/2-in.
WRENCH, socket, 7/8-in.
WRENCH, socket, 1 9/16-in.

b. Procedure (figs. 2, 9, 25, 86, 93 and 94).

(1) DISCONNECTING UNIVERSAL JOINT.

WRENCH, 7/16-in.
WRENCH, open-end, 9/16-in. (2)

Remove the front universal joint inspection plate by removing the four bolts and lock washers (7/16-in. wrench). Disconnect universal joint



RA PD 12411

Figure 94—Power Train on Jacks Prior to Removal

by removing the eight bolts (two $^{9}/_{16}$-in. wrenches) and self-locking nuts from the companion flange (fig. 86).

(2) Disconnecting Steering Arms (figs. 9 and 25).
PLIERS, 8-in. WRENCH, open-end, ¾-in.
SCREWDRIVER

(a) Remove the cotter pins from the clevis pins at the top end of the right and left steering linkage rods (pliers) and pull out the clevis pins, freeing the linkage.

(b) Disconnect linkage at right-hand end of right steering lever cross shaft by removing the cotter pin from the clevis pin, and remove the clevis pin.

(c) With screwdriver, pry up bottom seat of machine gun supporting spring, removing pin from seat in bracket. Remove the four cap screws (¾-in. open-end wrench) from each cross shaft bracket and lift off shaft and brackets.

(3) Removing Small Units (fig. 9).
WRENCH, open-end, $^{11}/_{16}$-in. WRENCH, socket, $^{9}/_{16}$-in.
WRENCH, open-end, ¾-in.

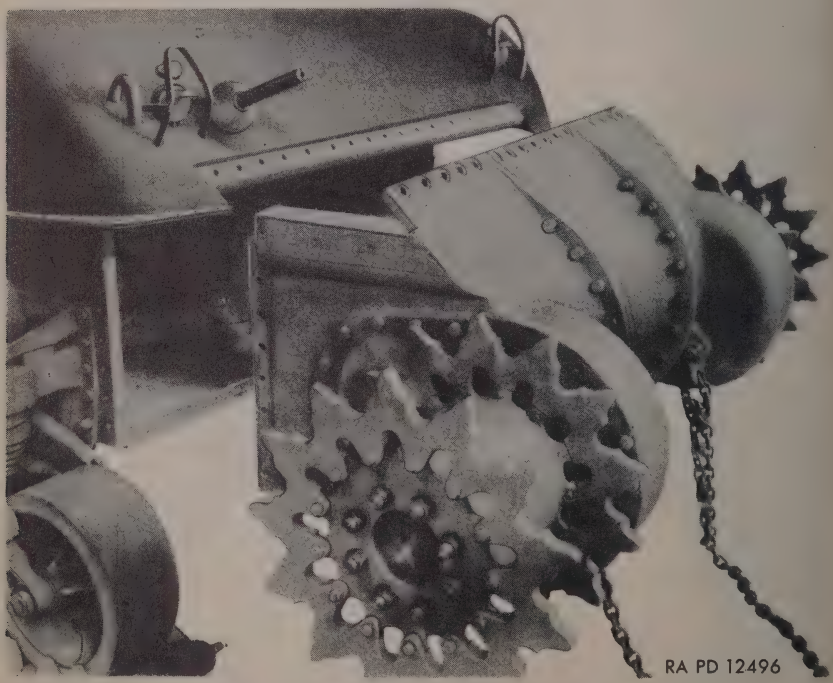


Figure 95—Power Train Removed from Tank

POWER TRAIN

(a) Remove the two cap screws ($^{9}/_{16}$-in. socket wrench) holding the hand throttle bracket to the housing and remove the throttle.

(b) Disconnect the speedometer cable from the right rear of the transmission housing by loosening the knurled nut. Tie cable up out of way.

(c) Disconnect the oil temperature gage line from the fitting at the oil inlet line on the left side of transmission ($^{11}/_{16}$-in. open-end wrench). Tie line up out of the way, being careful not to kink the cable or injure the bulb.

(d) Remove both stop light switch brackets by removing the cap screws ($^{3}/_{4}$-in. open-end wrench). Unhook the adjustable rod from each switch and remove the switches.

(4) Disconnecting Transmission Oil Cooler Lines.

WRENCH, open-end, $1^{3}/_{8}$-in. (2)

Do not attempt to disconnect the lines at the transmission first. This will injure the flexible lines, since the fittings are sweated onto the hose. Disconnect both oil lines at the floor (two $1^{3}/_{8}$-in. open-end wrenches). Then remove the flexible lines by turning them out of the fittings on the transmission housing ($1^{3}/_{8}$-in. open-end wrench). Cover fittings with cloth or tape.

(5) Removing the Cal. .30 Machine Gun (fig. 25).

Remove trunnion pin from right hand side of gun and lift gun out of mount. Spring will be removed with gun.

(6) Breaking the Tracks.

BAR, track, 27-in. WRENCH, socket, $^{7}/_{8}$-in.
HAMMER, sledge

(a) Loosen and remove the wedge nuts from the corresponding outside and inside connectors that are midway between the front sprocket and the front bogie wheel. Tap the wedges out of the connectors being careful not to injure the threads. Working from the opposite side of the track from the connector with the point of the track bar against the flange of the connector, drive the inside connector almost off the track pins. Leaving the inside connector on, in order to prevent binding of the outside connector on the pins, drive the outside connector off. Then drive the inside connector off the rest of the way. Work the top section of the track up and off the sprocket by turning the sprocket back with a bar, and pulling the track to the rear. NOTE: If difficulty is experienced in driving the connectors off the pins, loosen the track tension as described in paragraph 108 b (1) through (4).

(b) Repeat operation to break the track on the other side of the tank.

(7) REMOVING THE FRONT FENDERS (fig. 2).

EXTENSION, 12-in.
HANDLE, heavy-duty ratchet
SCREWDRIVER
SOCKET, 1⅛-in.
WRENCH, socket, ½-in.

(a) Remove the eight fillister-head bolts (½-in. socket wrench) that hold the right front fender to the hull, using a screwdriver beneath the fender to hold the bolts from turning.

(b) Using the 1⅛-in. socket with 12-in. extension and heavy-duty ratchet handle, remove the three cap screws and lock washers that hold the side plate of the fender to the final drive housing and remove the fender.

(c) Before removing the left fender (with same tool as right fender), disconnect the siren by loosening the knurled nut and pulling out the connection (fig. 2).

(8) FREEING THE POWER TRAIN HOUSING (figs. 2 and 94).

HAMMER
HANDLE, heavy-duty ratchet
JACK, 10-ton (3)
PLIERS, cutting
PUNCH, ¼-in.
SOCKET, 1⅛-in.
WRENCH, open-end, 1⅛-in.

(a) Remove the locking wire from the two cap screws in the line of bolts that hold the lower edge of the power train housing to the tank floor. Then remove the cap screws and lock washers (1⅛-in. socket wrench with heavy-duty ratchet handle).

(b) Install three 10-ton hydraulic jacks under the power train (fig. 94). Place one jack under the rear center of the controlled differential housing, one jack under the right final drive housing, and the third under the left final drive housing. Pull up the jacks until they are snug.

(c) With a second man inside the tank, to hold the nuts from turning (1⅛-in. open-end wrench), remove the remaining 20 bolts and lock washers from the bottom edge of the housing. Then remove all of the bolts from each side of the housing and those across the top (56 bolts in all).

(d) Drive out side plate shims (hammer and ¼-in. punch) from between the side plates of the chassis and the sides of the housing.

(9) REMOVING THE POWER TRAIN FROM THE TANK (fig. 95).

CABLES (2)
CHAINS (2)
TANK, second or wrecker

Lower each jack slightly and in rotation until the housing breaks clear of the hull of the tank. Be sure that jacks are on a solid foundation, and against flat sections of housing. As a safety precaution, anchor the housing, with chains to the clevises. With towing cable attach wrecker or second tank to towing clevises on either side of rear of tank. Slowly pull tank away from power train. CAUTION: Station a man inside the

tank to see that power train, transmission, and control levers (gearshift and parking brake) do not catch on any projections inside the hull.

(10) Blocking up Power Train.

BLOCKING

For the security of the power train, and to release the three jacks, install blocking under the final drive housings and the controlled differential and release the jacks. The blocking under the final drives should be about four feet long to avoid any danger of the housing tipping, and should be placed inside the jacks.

109. INSTALLING NEW OR REPLACEMENT POWER TRAIN.

a. Equipment.

BAR, track, 27-in.
BLOCKING
CABLE (2)
CHAIN (2)
EXTENSION, 12-in.
HAMMER
HAMMER, sledge
HANDLE, heavy-duty ratchet
JACK, 10-ton (3)
PLIERS, 8-in.
PUNCH, ¼-in.
SCREWDRIVER
SOCKET, 1⅛-in.
TANK, second, or wrecker
WRENCH, 7/16-in.
WRENCH, open-end, 9/16-in. (2)
WRENCH, open-end, 11/16-in.
WRENCH, open-end, ¾-in.
WRENCH, open-end, 1⅛-in.
WRENCH, open-end, 1⅜-in. (2)
WRENCH, socket, ½-in.
WRENCH, socket, ⅞-in.

b. Procedure.

(1) Lining up Tank and Power Train.

JACK, 10-ton (3)
TANK, second, or wrecker

When the new or replacement power train is delivered to the company, care should be taken to see that it is centered on the blocking to allow sufficient room for the installation of the jacks. It must also be accurately lined up with the tank at this time. Install the jacks under the differential and power train housings, as described in paragraph 108 b (8) *(b)*, and raise the unit high enough for the bottom of the unit to slide inside the tank. With blocking still in place, carefully push the tank up to the power train housing (wrecker or second tank). Station a man inside the tank to see that control levers and housing clear any projection in the tank.

(2) Installing the Housing in the Tank.

HAMMER
PUNCH, ¼-in.

Line up the holes in the housing and the tank chassis. This may require moving the tank slightly forward or backward, or raising or lowering one or more of the jacks. When holes are correctly lined up, install

and line up the side shims, driving them into place with a hammer and punch. Lower the jacks gradually, in rotation, until the top of the housing seats on the tank hull.

(3) ATTACHING HOUSING TO TANK.
HANDLE, heavy-duty ratchet SOCKET, 1⅛-in.
PLIERS, 8-in. WRENCH, open-end, 1⅛-in.

With a man inside to hold the nuts (1⅛-in. open-end wrench), install and tighten the top and side bolts and lock washers (56 bolts) (1⅛-in. socket wrench and heavy-duty ratchet handle). Remove blocking and install the 20 bottom bolts and lock washers and the two center cap screws and lock washers (1⅛-in socket wrench and heavy-duty ratchet handle). Wire the two cap screws together (pliers).

(4) CONNECTING PROPELLER SHAFT.
WRENCH, 7/16-in. WRENCH, open-end, 9/16-in. (2)

Line up the holes in the slip joint companion flange and the transmission flange and install the connecting bolts and lock washers (two 9/16-in. wrenches). Replace the inspection plate and tighten down into place with the four cap screws (7/16-in. wrench).

(5) CONNECTING THE STEERING LEVERS.
PLIERS, 8-in. WRENCH, open-end, ¾-in.

(a) Install the steering lever cross shaft on the top of the brake drum housings, and install and tighten the eight cap screws holding the shaft brackets to the housings (¾-in. open-end wrench).

(b) Install the clevis pin connecting the linkage to the right steering brake shaft.

(c) Install the clevis pin connecting the arm on the left end of the shaft to the clevis on the right adjustable rod.

(d) Install the clevis pin connecting the left steering brake arm to the clevis on the left adjustable rod. Secure all clevis pins with cotter pins (pliers).

(6) CONNECTING TRANSMISSION OIL COOLER LINES.
WRENCH, open-end, 1⅜-in. (2)

(a) Install and tighten the flexible inlet and outlet oil cooler lines to the fittings on the transmission housing (1⅜-in. open-end wrench). The long line (inlet line) should be connected to the "T" fitting toward the front of the transmission, and the short line (outlet line) to the elbow.

(b) Connect the other ends of the flexible lines to the oil cooler inlet and outlet lines on the floor (two 1⅜-in. open-end wrenches). Make connections carefully to be sure there will be no oil or air leaks.

(7) INSTALLING SMALL UNITS.
WRENCH, open-end, 1 1/16-in. WRENCH, open-end, ¾-in.

(a) Install and tighten the oil temperature gage bulb into the "T" fitting on the transmission ($1\frac{1}{16}$-in. open-end wrench).

(b) Connect up the speedometer cable at the right side of the transmission.

(c) Hook the adjustable rods from the stop light switches on the left brake shaft arm and the arm on the left end of the cross shaft, and install and tighten the brackets on the housing ($\frac{3}{4}$-in. open-end wrench).

(d) Install and tighten the hand throttle bracket on the housing.

(8) INSTALLING THE CAL. .30 MACHINE GUN. Slide the barrel of the gun through the hull and set the gun into the mount. Install the trunnion pin to secure the gun. Compress the supporting spring and insert the bottom spring seat ball into the socket on the cross shaft bracket.

(9) REPLACING FRONT FENDERS.

EXTENSION, 12-in.
HANDLE, heavy-duty ratchet
SCREWDRIVER
SOCKET, $1\frac{1}{8}$-in.
WRENCH, socket, $\frac{1}{2}$-in.

Set the fenders in place. Install and tighten the eight fillister-head bolts ($\frac{1}{2}$-in. socket wrench) holding the fenders to the hull at the top, using a screwdriver under the fender to hold the bolts. Install and tighten the cap screws ($1\frac{1}{8}$-in. socket, 12-in. extension, ratchet handle) holding the side plate to the final drive housings. Install and tighten the siren conduit and cable into the fitting on the left side of the bow.

(10) CONNECTING THE TRACKS. Connect the tracks as described in section XXI, paragraph 112 c. (6), (7) and (8).

Section XXI

SUSPENSIONS AND TRACK

	Paragraph
Description and operation	110
Bogies	111
Tracks	112
Idlers and track supporting rollers	113
Installation of grousers	114

110. DESCRIPTION AND OPERATION.

a. Six two-wheeled, rubber-tired bogies or suspensions, bolted to the hull, support the vehicle on springs. The tracks are driven by sprockets on the front of the tank. Two adjustable idlers at the rear end of the hull are provided to maintain constant tension on the tracks. The weight of the upper portion of the track is carried by single steel track-supporting rollers seated on the top of the suspension brackets.

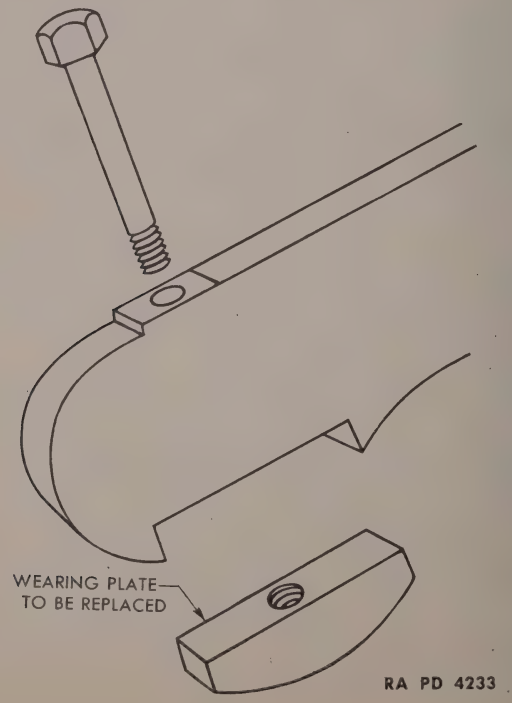


Figure 96—Bogie Wheel Lever and Upper Rubbing Plate

SUSPENSIONS AND TRACK

111. BOGIES.

a. Description and Operation. The bogies are the supporting and conveying units, and are sometimes called trucks or suspensions. The movement is transferred from the wheels to the arms and levers, and is absorbed by springs. Wear between the wheel arms and the spring levers is taken by upper and lower rubbing plates which are removable and can be replaced (fig. 96). On top of each bogie assembly is a single steel roller to support and carry the upper, returning portion of the track. The roller assemblies are bolted in seats on top of the bogie brackets.

b. Lubrication (fig. 23). Lubrication of the wheels and the track-supporting rollers is through lubrication fittings. Relief valves are provided to prevent injury to oil seals. See War Department lubrication guide for lubrication instructions (fig. 41).

c. Removal of Bogie Wheel (fig. 97). NOTE: Bogie wheels are removed either for replacement, to repair a tire, to inspect or replace bearings, to replace grease seals or spacers, or to make other necessary repairs.

EXTRACTOR, cotter key
JACK, hydraulic, 12-ton
PULLER, gudgeon (slide hammer)
WRENCH, gudgeon, 2 3/8-in.

(1) Place the 12-ton hydraulic jack on the track directly under the center of the suspension assembly and jack up the bottom spring seat until all suspension weight is removed from the bogie wheel arm (fig. 97).

(2) Remove the cotter pin from the nut on the inner end of the bogie wheel gudgeon (extractor) and remove the gudgeon nut (2 3/8-in. gudgeon wrench).

(3) Screw the slide hammer gudgeon puller into the threaded hole in the outer end of the gudgeon and pull the wheel gudgeon pin (fig. 98). Lift out the wheel from between the arms.

(4) Remove spacers and inspect grease seals and inner and outer bearings. Replace if worn or damaged.

d, Replacing Grease Seals and Bearings.

DRIVER, bearing
HAMMER, brass or aluminum drift
HAMMER, rawhide
PULLER, oil seal

(1) Pull out the two outer spacers.

(2) Support the wheel on blocks and, with a brass drift through the upper side of the wheel, drive the bearing and oil seals out of the lower side of the wheel. It will be necessary to move the inner spacer to one side in order to seat the drift on the outer race of the bearing.

Figure 97—Pulling Wheel Gudgeon to Remove Bogie Wheel

Keep the drift moving around the entire circumference of the bearing outer race, in order to drive it out evenly and with no damage to the bearing. The spacer will drop out when bearing is removed.

(3) Turn the wheel over and drift out the other bearing and oil seals.

(4) Clean and inspect both bearings for wear, cracked rollers or flat spots.

(5) Replace the bearing by starting it in by hand and tapping it lightly into place with a brass drift. Work around the outer race in the same way as in removal. Be sure the bearing is entirely seated against the shoulder, to allow the proper room for the grease seals.

(6) Slide two new grease seals into place on spacer, being sure that the seals are installed with the lips toward the shoulder of the spacer. Start the lower seal into the wheel and tap seals and spacer into place (rawhide mallet).

(7) Turn the wheel over, insert the center spacer, and install bearing, oil seals and outer spacer as in (e) and (f).

e. Replacing Bogie Wheel. A new or repaired bogie wheel is installed by the following procedure. Lift the wheel into place between the two arms. Raise the arms in line with the wheel and start the wheel gudgeon through the outer arm and into the outer spacer, grease seals and outer bearing of the wheel. Line up the center spacer by means of an alinement bar inserted from the inner side of the wheel and tap gudgeon into spacer. Then drive gudgeon through, into place, far enough to allow the key slot in the gudgeon to be lined up with the slot in the arm. Line up the slots, install the key, and drive the gudgeon in the rest of the way. Install and tighten the gudgeon nut on the inner end of the gudgeon and secure with a cotter pin.

f. Removal of Volute Springs. NOTE: The volute springs on medium tanks M4 series are not considered unserviceable and should not be replaced until they are broken or have taken a permanent set. Where three or more inner coils of both springs, in any suspension, rest upon the lower spring seat, and this condition is found to exist at more than one stop, then it is reasonable to assume that either one or both of the springs in that suspension have taken a permanent set and should be replaced.

BLOCK, wood
DRIFT, brass
HAMMER
JACK, hydraulic, 12-ton
PULLER, gudgeon
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 1 1/8-in.

(1) INSTALLATION OF JACK BENEATH SPRINGS.

JACK, hydraulic, 12-ton

Place the jack on the inside of the track in such a position that the head of the jack is in the center of the spring seat plate, and take up the

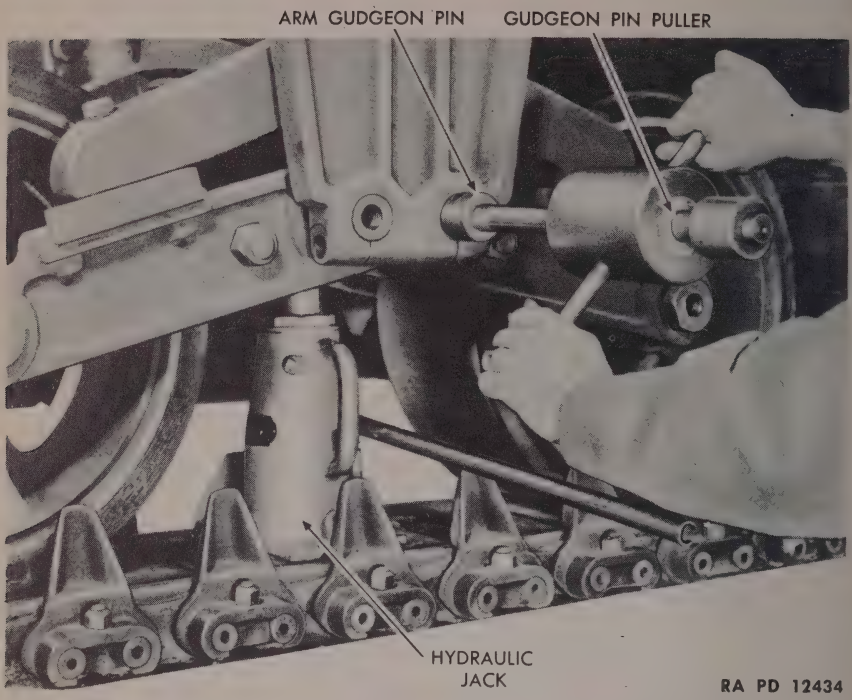


Figure 98—Pulling Arm Gudgeon Preparatory to Removing Volute Springs

thrust of the springs. In placing the jack, arrange the blocking so that the jack plunger is nearly at the upper end of travel when the thrust of the springs has been taken up. This procedure will permit a greater lowering travel later.

(2) RAISING OF JACK. Raise the jack until the thrust of the springs has been taken up.

(3) REMOVAL OF BOGIE WHEEL ARM GUDGEON BOLTS (fig. 97).

DRIFT, brass
HAMMER
WRENCH, open-end, $1\frac{1}{16}$-in.
WRENCH, open-end, $1\frac{1}{8}$-in.

(a) Loosen and remove the nuts ($1\frac{1}{16}$-in. and $1\frac{1}{8}$-in. open-end wrenches) on the locking bolts that secure the bogie arm gudgeons into the bogie bracket.

(b) Using a large drift and hammer, drive out the bolts.

(4) REMOVAL OF GUDGEONS (fig. 98).

PULLER, gudgeon

Screw a gudgeon puller into the threaded hole in the outside end of a bogie arm gudgeon and pull the gudgeon outward. Remove the other

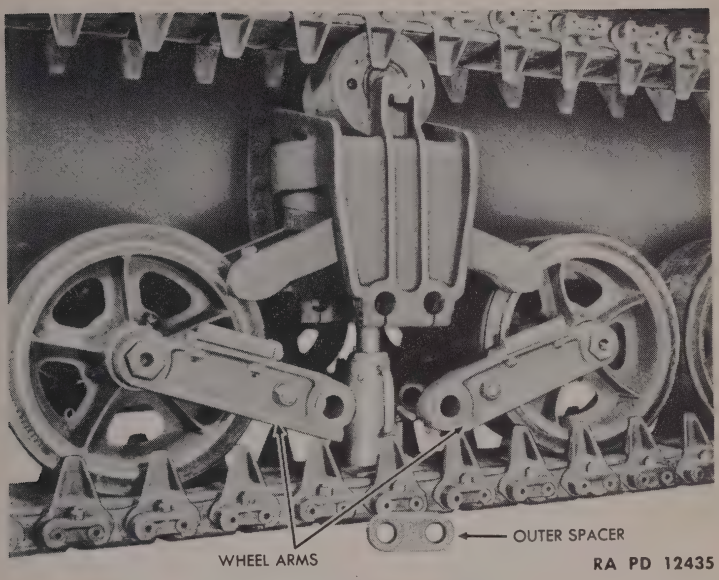


Figure 99—Wheels and Arms Ready for Removal Preparatory to Removing Volute Springs

bogie arm gudgeon, using a gudgeon puller. NOTE: When the gudgeons are pulled out the bogie arms and spacer plates will drop.

(5) LOWERING SPRING SEAT.

(a) Lower the jack with the spring seat plate and springs.

(b) If the jack has not sufficient travel to decompress the springs, push two bars through the gudgeon pin holes and lower the spring seat plate onto these. Then remove the blocking or lower adjustable jack screw, lift the plate off the bars, remove the bars and continue to lower the jack and decompress the springs.

(6) REMOVAL OF JACK AND SPRINGS.

BLOCK, wood
HAMMER

If the spring seat plate and springs do not pull out on removal of the jack, knock them out with a hammer or a block of wood. NOTE: When replacing springs always replace both springs—never one old and one new spring.

g. Installation of Volute Spring.

HAMMER
JACK, 12-ton
JACK, hydraulic, 12-ton
PULLER, gudgeon
WRENCH, open-end, $1\frac{1}{16}$-in.
WRENCH, open-end, $1\frac{1}{8}$-in.

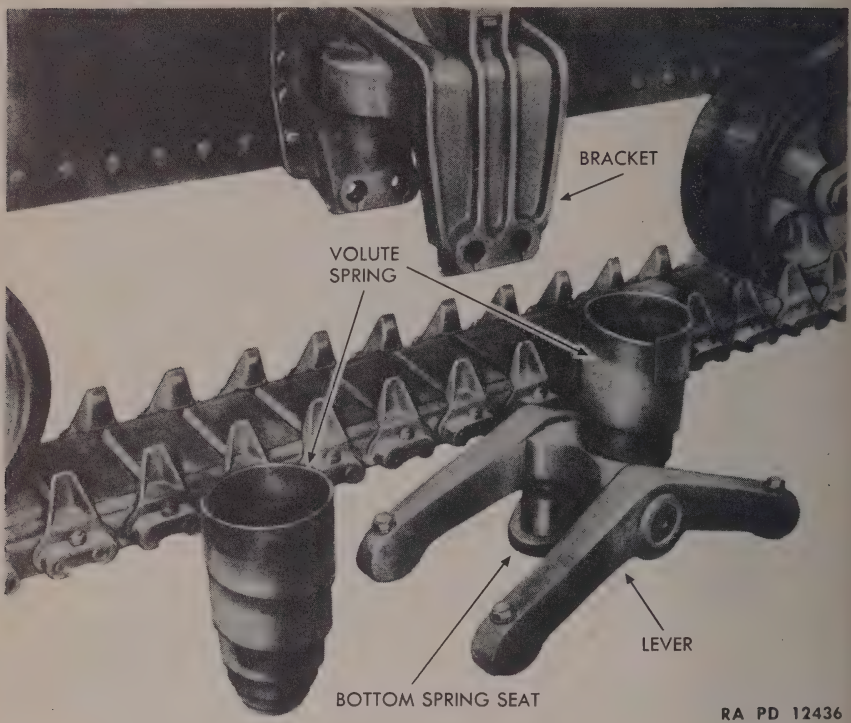


Figure 100—Volute Springs, Levers, and Bottom Seat Removed

(1) INSTALLATION OF SPRINGS.

JACK, 12-ton

Install the springs and spring seat plate. With a 12-ton jack compress the springs by raising the jack until the thrust of the springs has been taken up.

(2) INSTALLATION OF ARM GUDGEONS.

PULLER, gudgeon

Install the bogie arms and spacer plates in place and, using a gudgeon puller, install the gudgeon pins. Line up gudgeons so that grooves are in line for installation of locking bolts.

(3) INSTALLATION OF GUDGEON BOLTS.

HAMMER

WRENCH, open-end, 1⅛-in.

WRENCH, open-end, 1 1/16-in.

Install the gudgeon locking bolts, using a hammer to drive them into place. Install the nuts on the gudgeon locking bolts (1 1/16-in. and 1⅛-in. open-end wrenches).

(4) REMOVAL OF JACK. Lower and remove the jack, allowing levers to resume normal position on wheel arms.

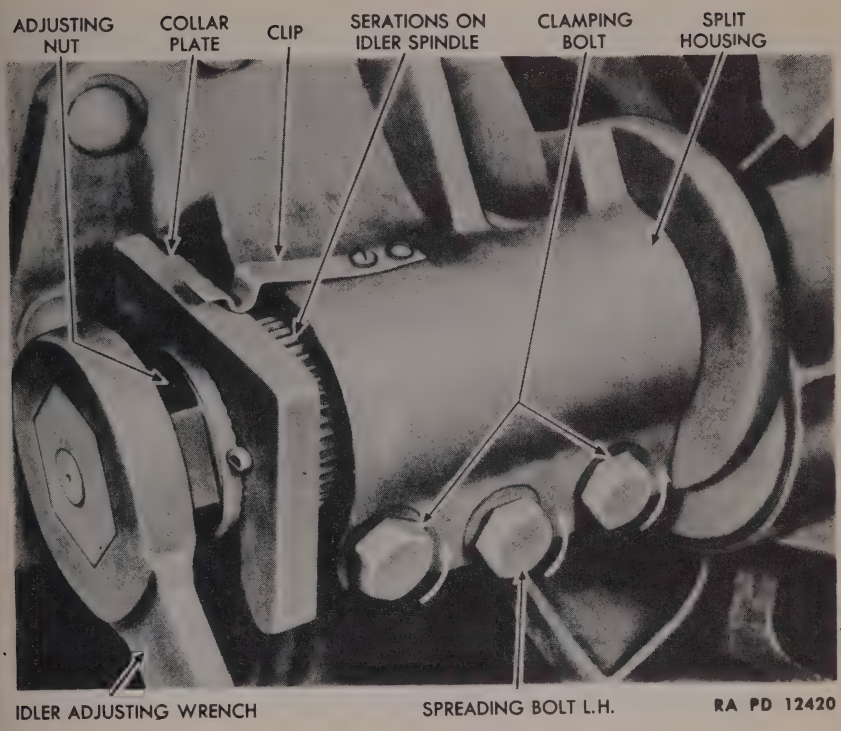


Figure 101—Adjusting Track with Idler Adjustment

112. TRACKS (figs. 20, 21, 22, 101, 102 and 103).

a. Description (fig. 21). Each track on the M4 series tanks has 79 individual steel or rubber blocks. Rubber blocks except those with chevron tread, are reversible and can be turned over to lengthen the life of the track. Two parallel pins, projecting from either end of each block, form anchorage points for the connectors, which link the blocks together on both sides to form a continuous track. Each track pin has rubber doughnut shaped spacers vulcanized on it, and these spacers, when the pin is pressed in the forged frame of the track block, form a flexible bond between the pin and the block. The connectors are held to the pins by wedges, which fit into milled slots on the pins. These slots face outward and are vertical to the flat side of the block. The wedges are tapered at a 7½ degree angle on each end, so that when they are pulled up between the two pins by the bolt, which is an integral part of the wedge and which projects up through the connector, they cause a 15 degree angle between adjacent blocks. This 15 degree angle tends to make the track curve up sharply behind the rear bogie, around the idler and on around the sprocket. Without the 15 degree angle, the track would tend

to travel straight out due to centrifugal force. Steel perpendicular end plates, cast integral with the connectors, serve as guides to keep the track in alinement with the bogie wheels, idlers, track support rollers and drive sprockets. The sprocket drives the track through the sprocket teeth, which engage the track between adjacent connectors. Since the condition and effectiveness of the track can definitely limit or increase the performance ability of the tank, it is essential that it be inspected, adjusted, and maintained in the best possible condition.

b. Adjusting a Track (figs. 20, 21 and 101). NOTE: The track should be checked daily for too much sag. If a pronounced sag is present, the correct tension should be restored to eliminate the possibility of the track being damaged or thrown off because of looseness. Figure 20 shows a track very definitely in need of tightening, while figure 21 shows the same track tightened up to eliminate the excessive sag. Adjusting track tension is done in the following steps.

HAMMER
WRENCH, adjusting, idler
WRENCH, socket, 1½-in.

(1) Using a 1½-in. socket wrench, loosen the two outside clamping bolts which clamp the split housing to the idler spindle (fig. 101).

(2) With the same wrench, turn down the spreader bolt to open up the housing. NOTE: Because this bolt has a *left-hand* thread, it is turned counterclockwise to turn it down.

(3) Raise the clip at the end of the housing, and, using a hammer, tap the collar plate off the serrations on the spindle to the position shown in figure 101.

(4) Tighten the track by using the idler adjusting wrench on the hex at the end of the spindle. Raise the handle of the wrench until the track shows a sag of ¾ to 1 inch measured between the two front support rollers. NOTE: Lay a straightedge along the track connecting the two front support rollers. Measure the sag from the straightedge to a point midway between the rollers. NOTE: To *loosen* track, lower the handle of the wrench.

(5) Drive the collar plate back on the serrations and under the clip.

(6) Loosen the center spreader bolt by turning it out clockwise.

(7) Pull both outside clamping bolts up tight and tighten down spreader bolt sufficiently to hold it from jarring loose.

c. Replacing Dead Track Block (figs. 22, 102 and 103). NOTE: A dead track block is one in which the flexible bond between the pin and forged frame of the block has failed, leaving the pin free to turn more than it should and tending to make the block travel straight instead of curving up sharply behind the rear bogie, around the idler and on around

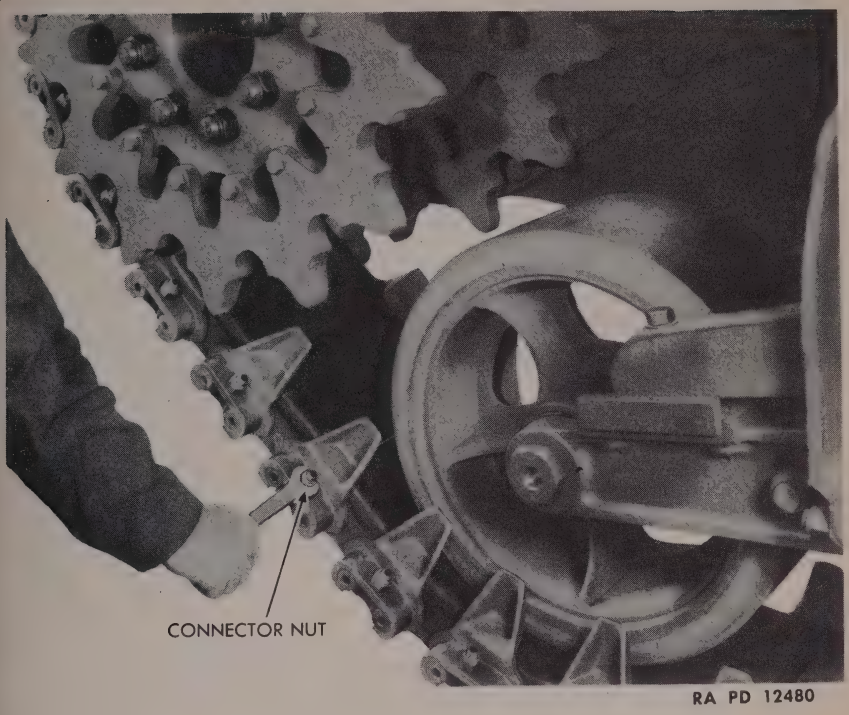


Figure 102—Removing Track Wedge Nut

the sprocket. Dead blocks are easily recognizable (fig. 22) and should be replaced immediately, as they may result in a broken track.

BAR
CHAIN, track
HAMMER
JACK, simplex
WRENCH, box, 7/8-in.

(1) Move tank so that block to be replaced is midway between the idler and the rear bogie wheel. Set the parking brake on the tank.

(2) Release the track tension as described in paragraph 112 **b.**

(3) Using a 7/8-inch box wrench, remove the wedge nuts (fig. 102) on the two inside and two outside connectors adjacent to the block to be replaced. Tap out wedges, being careful not to injure threads.

(4) Break the track (108 **b.** (6) except operation is done below idler instead of sprocket) and remove the block by driving off the other two connectors, using a bar and hammer.

(5) Install the new block to one end of the track by tapping the connectors into place with a hammer. Install the wedges in the connectors and, using a 7/8-inch box wrench, draw the wedges into place. NOTE: Inspect wedges and wedge nuts, and replace if worn or damaged.

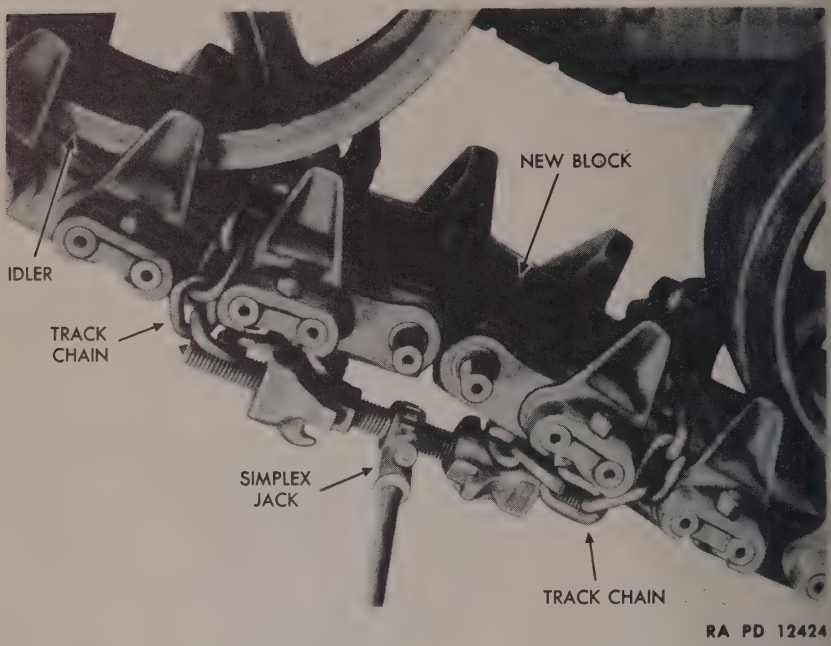


Figure 103—Replacing a Dead Track Block

(6) Hook chains to the two ends of the track, as shown in figure 103, and position the simplex jack.

(7) Draw the chains together with the jack and install remaining set of connectors.

(8) Install wedges and draw into place by installing and tightening the wedge nuts.

d. Turning Rubber Track Blocks (fig. 102). NOTE: Where track blocks are to be turned, or where several blocks must be replaced, the track should be removed from the tank, as described in the following procedure. Note that when removing the track, the track is broken at the front of the tank, between the sprocket and the front bogie wheel, instead of at the rear as described for the replacement of a single block.

HAMMER
JACK, simplex, with chains
WRENCH, box, 7/8-in.

(1) Break the track, as described in paragraph 108 **b** (6).

(2) Move the upper portion of each track to the rear over the drive sprocket and supporting rollers by turning the sprocket with a bar placed between the stud nuts.

(3) Break the track back of the rear bogie.

(4) Turn the blocks of the part of the track rolled off by removing

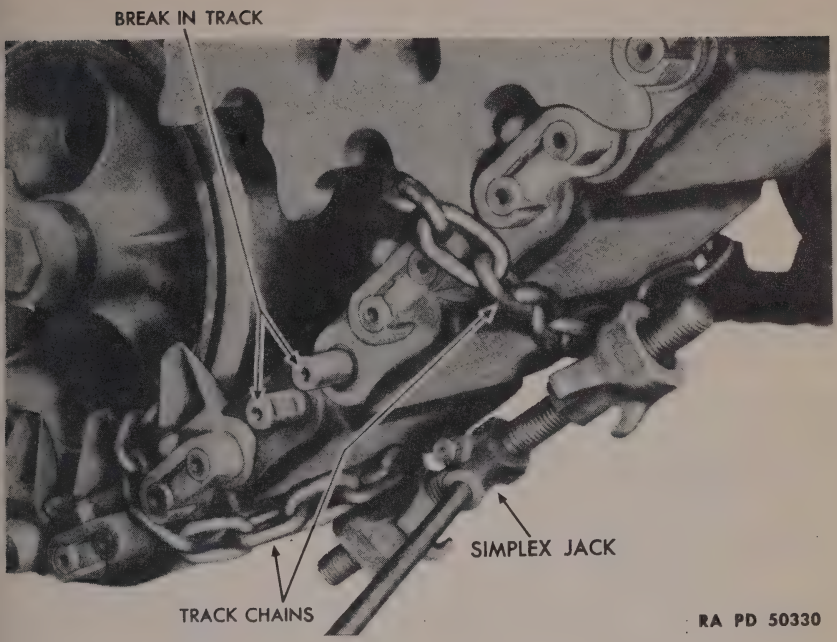


Figure 104—Joining Track at Front Sprocket

all the connectors and turning the blocks over. To equalize the wear on the connectors, turn them end for end and install them on the opposite side of the track. Connect this section of the track to the section underneath the bogie wheels and, using another tank, tow the dead tank back onto the section already reversed.

(5) Disconnect the remaining section of the track and reverse its blocks and connectors as outlined in step (4).

(6) Connect the two sections of the track, tow the tank onto the front section, and roll the rear section over the idler support rollers and sprocket, using a bar between the hub nuts to bring the track around the sprocket (see f for use of engine in this operation).

(7) Connect the track as shown in figure 104.

e. Replacing Thrown Track (fig. 103). Because conditions under which a track may be thrown vary so greatly, there is no one procedure that can be set down as the best possible method for replacement of a thrown track. Following is a procedure that can be used under the worst type of conditions and that can be modified for different situations.

(1) Break the track underneath, either, the idler or the sprocket, depending on which end has the least twist.

(2) Roll tank completely off the track by towing it with another tank.

(3) Roll up track and move it to the front or to the rear of the tank, depending on which side has the best and smoothest ground for towing the tank back on the track.

(4) Lay the track out with one end under the nearest bogie and with the same end in a trench dug deep enough so that the bogie can roll directly onto the track without having to raise up over the bump made by the first block of the tank.

(5) Tow the tank onto the track until about 16 inches of one end of the track protrudes beyond the front bogie wheel of the tank.

(6) Roll the track up over the idler, support roller, and around the sprocket, using a bar between the hub nuts to connect the track (fig. 104). NOTE: Sometimes the track may be thrown in such a manner that proper manipulation of the tank and the use of blocks make it possible to throw the track back on again.

f. Installing New Track. Following is the procedure for installing a new track when the old track is still on the tank.

(1) Break the old track under the sprocket and roll the track back off the tank, using a bar in the sprocket hub nuts.

(2) Lay out the new track in front of the old one and connect the two.

(3) Tow the tank onto the new track until about 16 inches of the track protrudes beyond the front bogie wheel.

(4) Disconnect the old track and roll the new one up over the idlers, the track support rollers and around the sprocket, and connect (fig. 104). NOTE: To install a new track when the old track is off the tank, proceed as in steps 3, 4, 5 and 6 under e of this paragraph.

g. Reversing the Track (figs. 104 and 105). To equalize the driving wear on the track connectors and thus lengthen the operating life of the track, the entire track can be reversed or turned end for end. This will shift the driving wear to the opposite ends of the connectors. Under good ground conditions the shift can best be done by breaking the tracks at the front, just below the sprocket, working the tracks up and off the sprockets, and pulling the tank completely off both tracks. The following field method can be used, however, when it is an advantage because of mud, soft ground, or other conditions, to keep the tank on part of the track at all times, and to move the tank under its own power.

(1) Break the right track at the rear, just below the idler, and using the left track for traction, move the tank ahead until the end of the right track comes off the sprocket. Break the right track at the center, turn the free section around end for end and drive the connectors on far enough, to hold the track together.

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Figure 105—Pulling Track Forward Over Idler Using Cable on Sprocket Hub

(2) Move the tank back until the bogie wheels are on the reversed section of the track. Reverse the other half of the track and reconnect the track, this time driving the connectors completely on and pulling down the wedges.

(3) Move the tank forward until the front bogie wheel is on the fourth track block from the end. Attach the towing cable by means of a chain to the other end of the track, bringing the free end of the cable up over the idler and support rollers and around the hub of the sprocket. Insert a short bar through the sprocket and the towing eye of the cable and using the sprocket hub as a windlass, pull the track forward to the sprocket with the engine power of the tank (fig. 105). NOTE: Both steering levers should be left free for this operation.

(4) Remove cable from sprocket drum, work track over sprocket, and connect the track as described in paragraph 112 d (6) (fig. 104).

(5) Repeat the operations on the left track.

113. IDLERS AND TRACK SUPPORTING ROLLERS (fig. 106).

a. **Description.** Two large steel idler wheels are mounted on the end opposite the driving sprockets to support the tracks. They are pro-

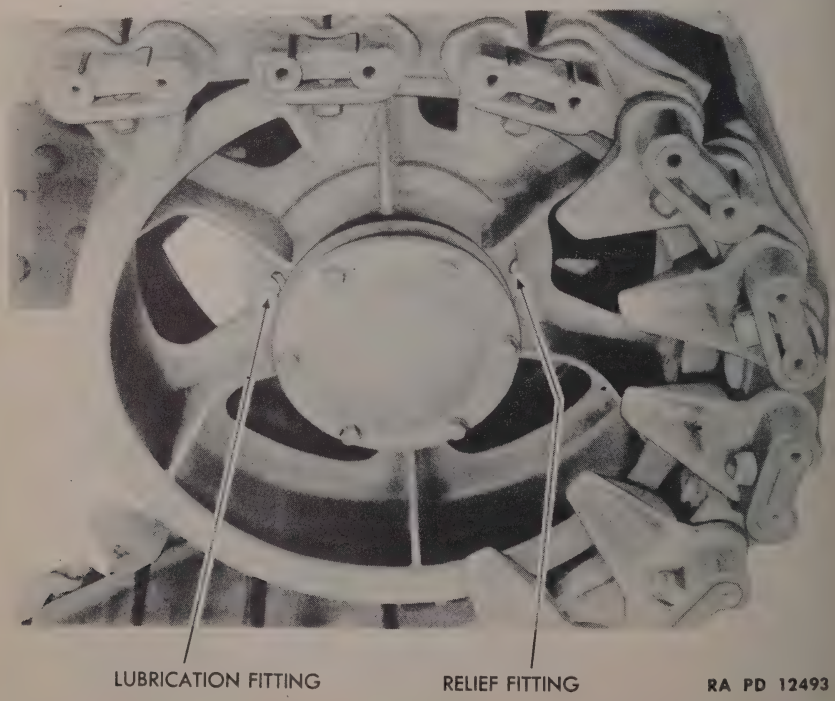

Figure 106—Detail of Idler

vided with an eccentric adjustment for the purpose of adjusting the tension of the tracks. The track supporting roller supports the weight of the track between the idler and the drive sprocket.

b. Idler Adjustment. See paragraph 112 b.

c. Lubrication. A lubrication fitting adaptable to the grease gun is installed in the hub of the idler. The track supporting roller has a lubricating fitting. Both are equipped with relief fitting. See lubrication guide (fig. 41) for lubrication instructions.

d. Removing Idler Wheels (with track removed).

PLIERS
WRENCH, socket, 3/8-in.
WRENCH, open-end, 2 3/4-in.

(1) Remove the idler cap by removing six cap screws.

(2) Take out split pin securing the wheel nut and remove the nut.

(3) Remove the wheel. NOTE: Before replacing the wheel, clean the bearings, oil retainers, and spacer.

e. Installation of Idler Wheel.

PLIERS
WRENCH, socket, 3/8-in.
WRENCH, open-end, 2 3/4-in.

(1) Install the wheel in place.

(2) Install the wheel nut and the split pin.

(3) Install the idler cap and the six cap screws.

(4) Pack inner and outer bearings with grease.

f. Removing Track Supporting Roller.

PLIERS
WRENCH, box, 13/16-in.

Remove the locking wire (pliers) and the four cap screws (13/16-in box wrench) holding the roller in place. Lift out the track supporting roller.

g. Installing Track Supporting Roller.

PLIERS
WRENCH, box, 13/16-in.

Place the supporting roller in position and secure in place with the four cap screws (13/16-in. box wrench). Install the locking wire (pliers).

114. INSTALLATION OF GROUSERS (fig. 107). NOTE: There are 13 grousers provided for each track, one for every sixth track block, and each grouser must be installed separately.

a. Equipment.

WRENCH, socket, 15/16-in.

b. Procedure.

(1) Place the grouser over the track so that it is across the opening

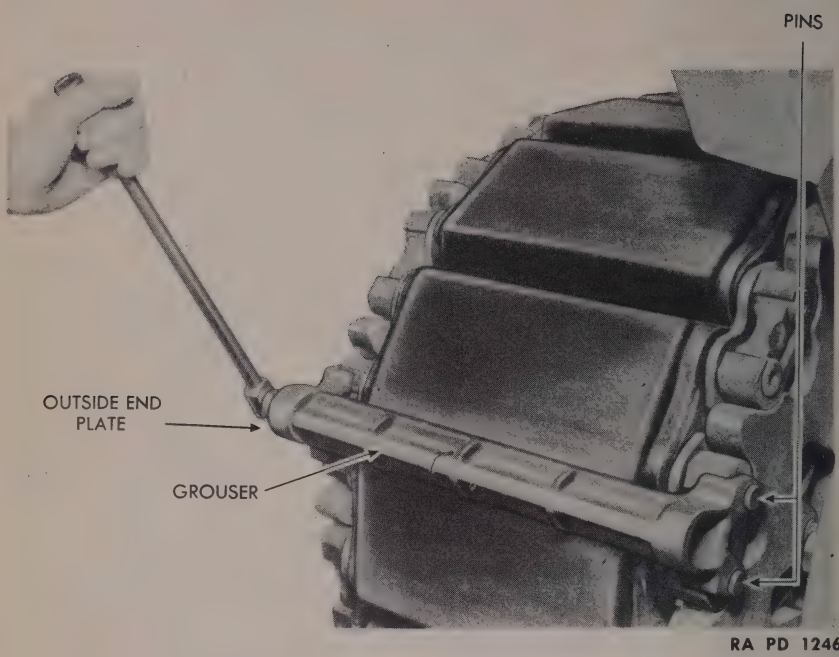

Figure 107—Installing Grouser

between two track blocks and slide the two pins on the inside grouser end plate into the holes in the track block pins.

(2) Install the pins on the outside grouser end plate in the corresponding outer track block pins and fasten the plate to the grouser with the special bolt and lock washer.

(3) Tighten the bolt with a $1\frac{5}{16}$-inch socket wrench.

(4) To install grousers on the lower part of the track, it will be necessary to move the tank.

Section XXII

ELECTRICAL AND IGNITION SYSTEMS

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115. GENERAL DESCRIPTION (figs. 108, 109, 110, and 111).

a. Due to the large number of electrically operated accessories, a 24-volt electrical system is installed. An auxiliary generating plant, described in section IV, equipped with a small motor and generator,

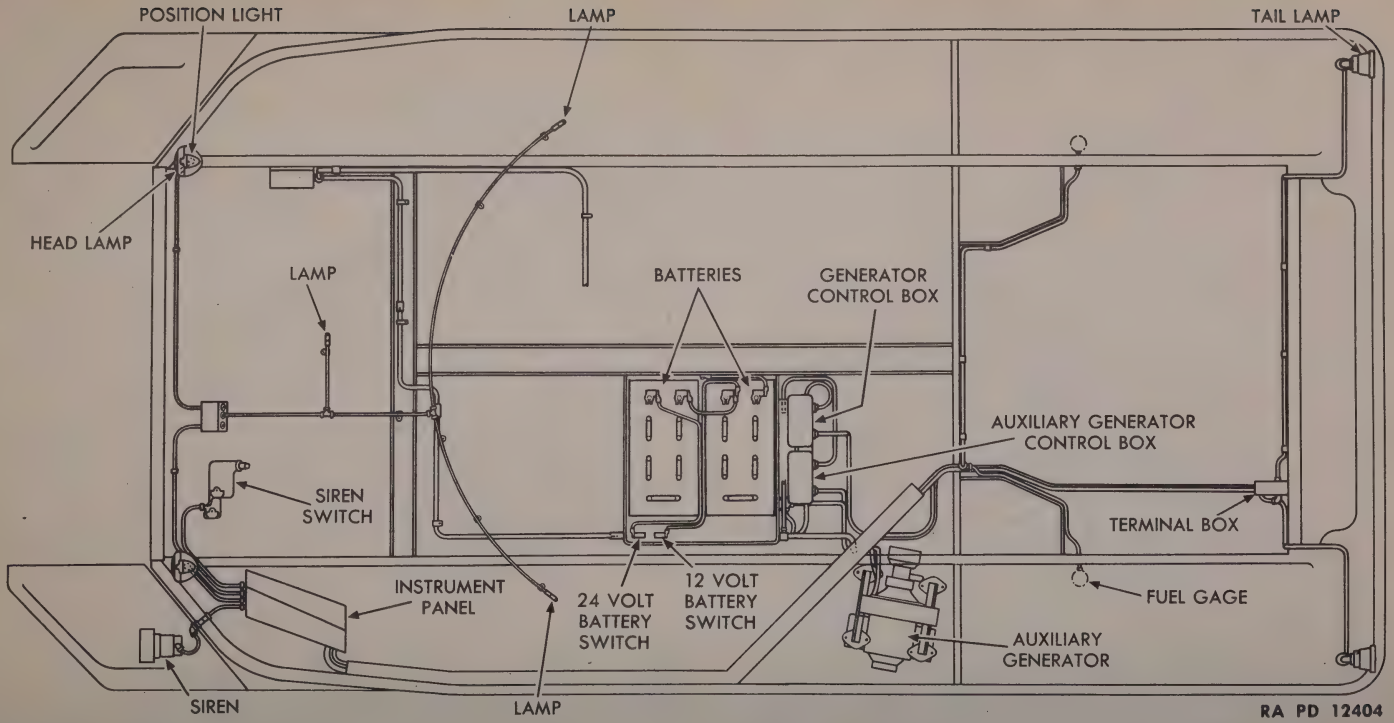

Figure 108—Diagram of Electrical Installation (Except Turret)

Figure 109—Diagram of Turret Electrical Installation

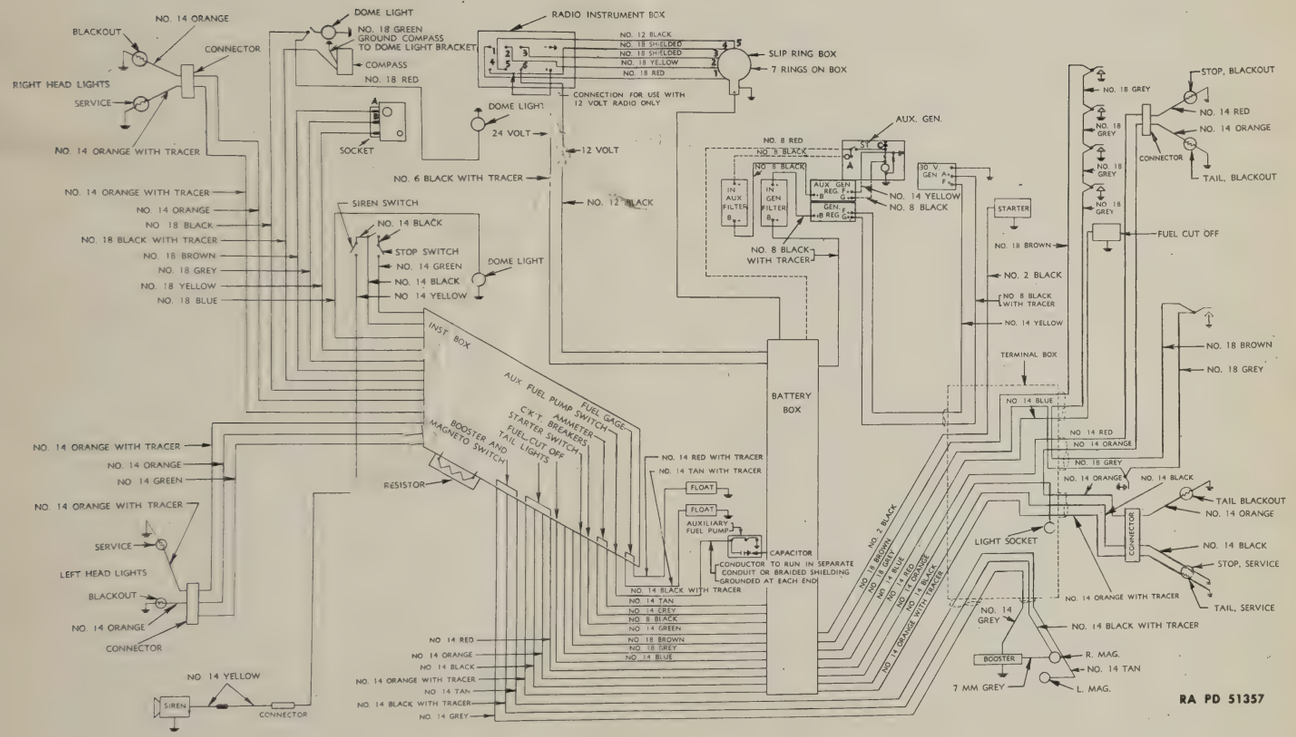

Figure 110—Wiring Diagram—Hull

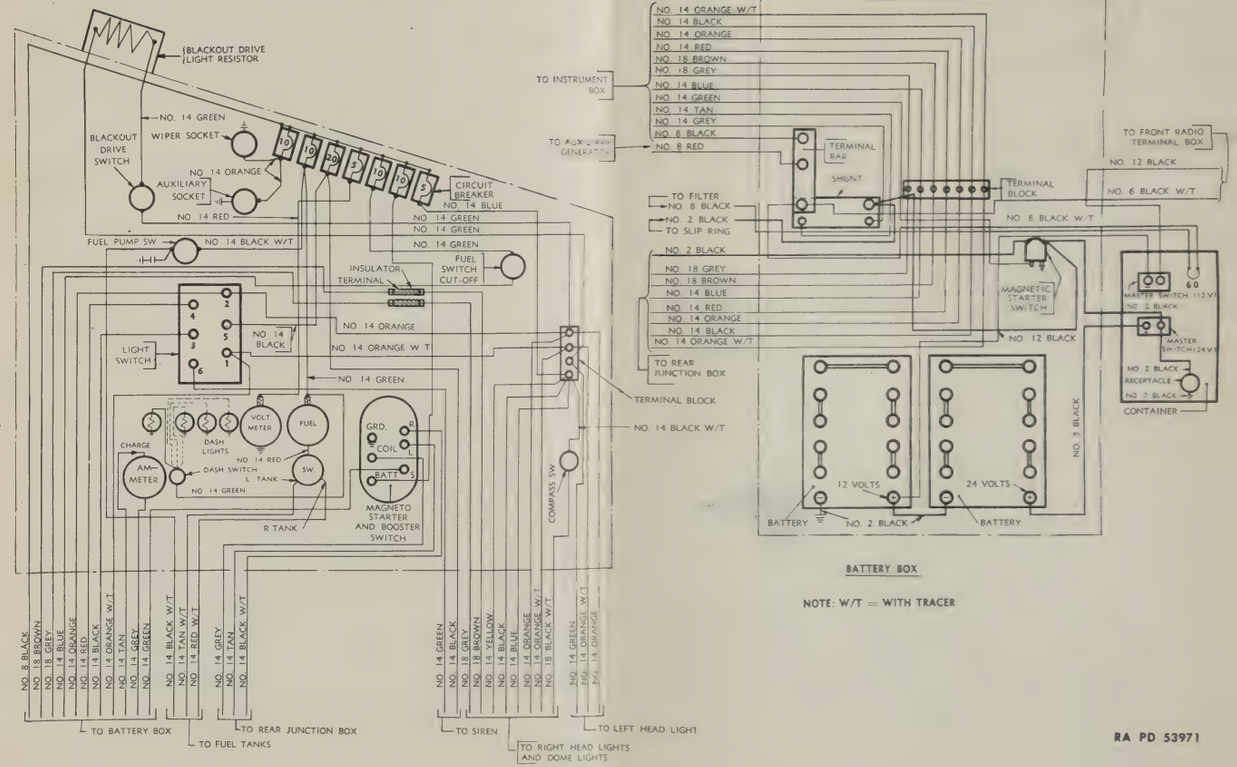

Figure 111—Wiring Diagram—Instrument Panel

has also been installed to supply extra power and aid in charging the batteries. The diagrams (figs. 108, 109, 110, and 111) show the location of electrical units and wiring in the tank and the turret.

116. BATTERY (figs. 111 and 112).

a. Description. Two 12-volt storage batteries are connected in series to give a 24-volt electrical system. The batteries are installed in the battery compartment, located on the left side of the floor in the fighting compartment, behind the driver, and under the turret basket floor. A 12-volt circuit is taken off the battery for the radio switch.

b. Checking. The level and specific gravity reading of the battery fluid should be checked every week and at the end of every long run. Distilled water should be added when necessary to bring the fluid level up to $\frac{3}{8}$ of an inch above the tops of the plates. If the specific gravity of any cell is below 1,250, the battery should be recharged. If the specific gravity is at 1,250, the engine should be hand cranked when starting.

c. Removal.

WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $1\frac{1}{16}$-in.

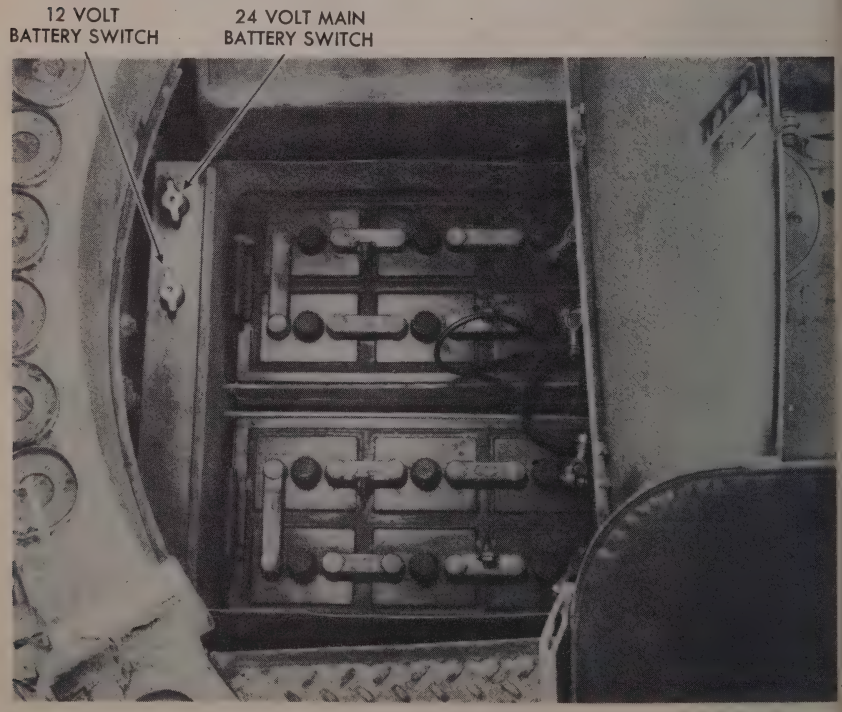

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Figure 112—Location of Batteries and Battery Switches

(1) Open the main battery switch (fig. 113).

(2) Lift cover from battery box.

(3) Disconnect the battery cables (check legibility of markings).

(4) Remove the bracket hold-down bolts.

(5) Remove the battery through the opening in the turret floor and ut of the tank through the turret hatch.

d. Installation.

WRENCH, open-end, $^{7}/_{16}$-in. WRENCH, open-end, $^{11}/_{16}$-in.
WRENCH, open-end, $^{9}/_{16}$-in.

(1) Install the battery, the hold-down bolts and the battery cables.

NOTE: When mounting batteries, see that the positive terminals are ext to the propeller shaft; that the posts and the terminals have been leaned; that after the clamps have been installed, and coated with etrolatum, the terminals are tight.

(2) Replace the cover.

17. BATTERY SWITCH (fig. 113).

a. The battery switch is mounted on the left side of the battery box, nd is provided to cut off the battery current at its source. A second

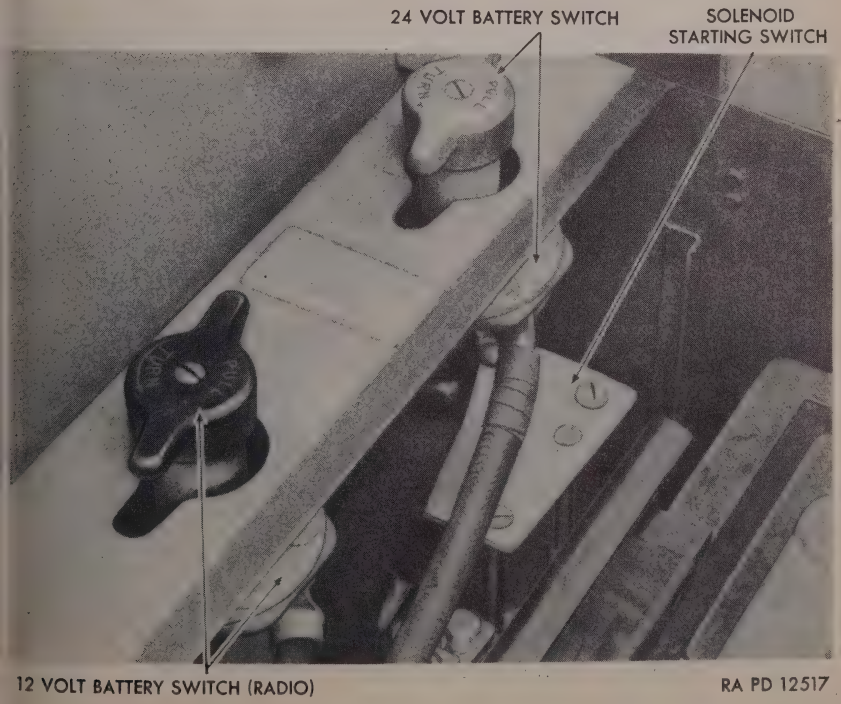


Figure 113—Main Battery Switches and Solenoid Starting Switch

switch is also provided in the same box for cutting of the radio circuit. To open either circuit, turn and raise the knobs and turn as indicated by arrow.

b. Removal of Battery Switch (fig. 113). NOTE: If the battery switch becomes damaged in any way or no longer makes a good contact, it must be removed for repair or replacement. Burning or pitting due to arcing when the switch is opened or closed, may cause a bad contact and necessitate removal for repair or replacement. To remove and replace a switch, use the following procedure:

SCREWDRIVER WRENCH, open-end, 5/8-in.

(1) Remove partition separating battery and switch compartments.

(2) Remove the switch knob by removing the retaining screw (screwdriver).

(3) Remove the terminal nuts and the leads. Insulate live leads to prevent a possible short circuit while they are disconnected.

(4) Remove the two retaining bolts.

(5) Remove the switch.

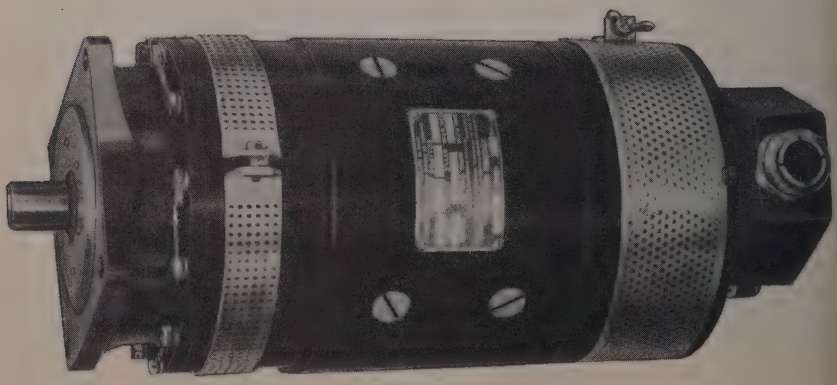
c. Installation.

SCREWDRIVER WRENCH, open-end, 5/8-in.

Install switch with the retaining bolts and install the terminal leads, the terminal nuts, the switch knob and the retaining screw in the order named.

118. GENERATOR (figs. 53, 114 and 115).

a. Description. The generator is flange-mounted on the accessory case below the starter and is held in place by four studs with safety lock nuts. The voltage control box described (par. 119) of this section con-



RA PD 2733

Figure 114—Generator

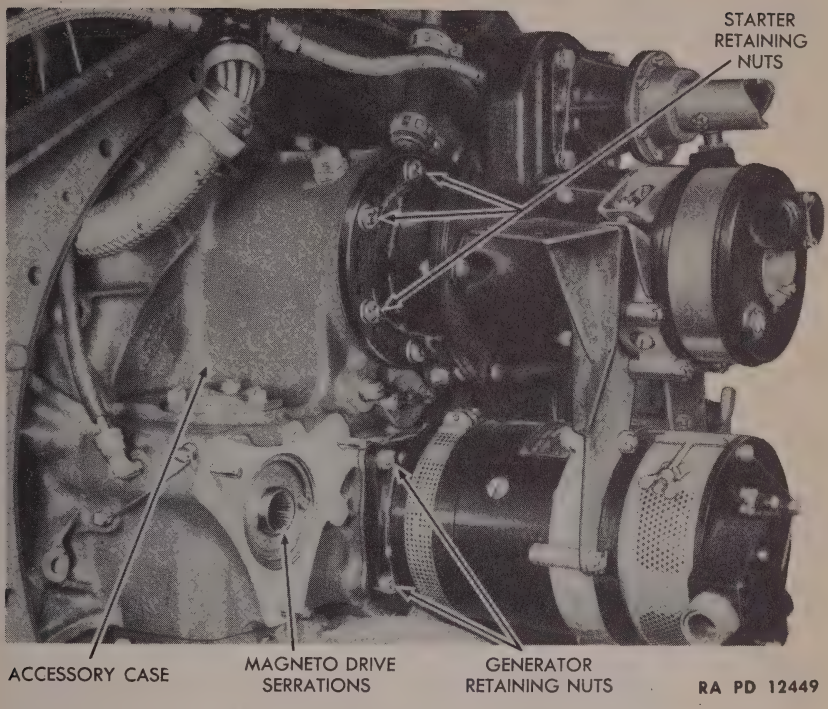


Figure 115—Left Magneto Removed to Show Retaining Nuts for Starting Motor and Generator

trols the current output of the generator. A shielded coil is provided, in the generator-battery circuits, to reduce radio interference. Separate filters are supplied for the generator on the engine and the auxiliary generator. They are located on the floor of the fighting compartment, behind the battery box.

b. Lubrication. Generators are properly lubricated at engine overhaul periods and do not require any additional lubricant between overhaul periods.

c. Removal.

SCREWDRIVER
WRENCH, box, ½-in.
WRENCH, leather strap
WRENCH, socket, ⅜-in.

(1) Open battery switch.

(2) Remove the terminal guard and disconnect leads. NOTE: All leads should be marked to identify their proper position for reconnecting.

(3) Remove the four stud nuts holding the generator to the accessory case.

(4) Loosen the generator retaining bracket nut and slide the generator to the rear.

d. Installation.

SCREWDRIVER WRENCH, socket, ⅜-in.
WRENCH, box, ½-in.

(1) Install generator in place over studs and tighten retaining bracket nut.

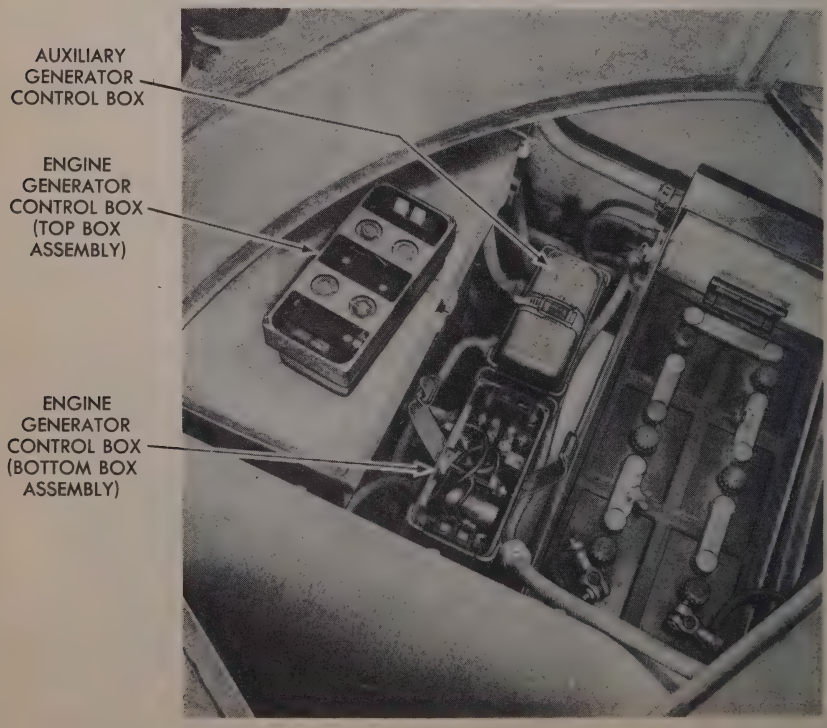
(2) Install four safety nuts that hold the generator to the accessory case.

(3) Hook up leads and install terminal guard.

e. Oil Leakage. If excessive oil is present in the generator at the time of inspection, the generator should be replaced.

119. GENERATOR REGULATOR (fig. 116).

a. Description. To prevent overcharging of the batteries, the generator on the engine and the auxiliary generator are equipped with individual generator regulators. These boxes are of the three-unit detachable type, and are located near the floor of the fighting compartment, behind the battery box. They include a voltage regulator, current regulator and reverse current relay. The right generator regulator is for the engine generator; the left for the auxiliary generator.


AUXILIARY GENERATOR CONTROL BOX
ENGINE GENERATOR CONTROL BOX (TOP BOX ASSEMBLY)
ENGINE GENERATOR CONTROL BOX (BOTTOM BOX ASSEMBLY)

RA PD 12465

Figure 116—Detail of Generator Regulator Boxes

(1) The voltage regulating unit maintains the output of the generator at a constant predetermined voltage of 28.4 volts. The current output of the generator is automatically varied in accordance with the state of charge of the battery and the amount of current being used throughout the vehicle. Thus the proper charge is delivered to the battery at all times without danger of overcharging.

(2) The current limitator unit limits the maximum current output to a value slightly in excess of the rated capacity of the generator.

(3) The reverse current relay or cut-out prevents the battery from discharging through the generator when the generator is at rest or when it is not developing its normal voltage.

b. Inspection and Adjustments. If inspection reveals loose or faulty contacts, improper operation, a blownout fuse, or if the voltage as indicated by the voltmeter is consistently above or below normal, the unit should be replaced. To replace a unit, open battery switch, release the spring catch and take the top box off the base box and install new unit. In pulling the top box from the bottom box, the operation is similar to removing a tube from a radio set (fig. 116). CAUTION: Before attempting to inspect or replace the control box, make sure the main battery switch is open.

120. BUS BAR.

a. The bus bar, a low resistance connection for common circuits, is located in the rear of the battery compartment. Current comes from the battery and the generator to the bus bar and on the circuit breakers and switches.

121. CIRCUIT BREAKERS (fig. 11).

a. Circuit breakers, located behind the instrument panel, are provided on the M4 and M4A1 Tanks to prevent overloading of a circuit. In the event of an overload, the circuit breaker automatically breaks the circuit. When this happens, the circuit can be completed again by pushing in the proper reset button located on the instrument panel. If circuit breakers continue to throw out after being reset, the circuit under its control must be checked for overload or a short circuit.

122. SOLENOID STARTER SWITCH (fig. 113).

a. General. A solenoid starter switch is located in the battery box beneath the main battery switch. It eliminates the necessity of running heavy cables up to the instrument panel and, therefore, eliminates voltage drop. This switch is actuated by a toggle type starter switch located on the instrument panel.

b. Removal.

SCREWDRIVER
WRENCH, open-end, $\frac{5}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.

(1) Disconnect leads.
(2) Remove screws that hold solenoid to battery box.
(3) Lift out solenoid.

c. Installation.

SCREWDRIVER
WRENCH, open-end, $\frac{5}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.

(1) Install solenoid in place.
(2) Install screws.
(3) Connect up leads.

123. INSTRUMENT PANEL (fig. 11).

The instrument panel is located in the left front sponson next to the driver and contains the various electrical and non-electrical instruments, meters and switches listed below (fig. 11).

a. Voltmeter. The voltmeter indicates the voltage in the circuit and is connected through a 10-ampere fuse.

b. Ammeter. The ammeter indicates the amount of current in amperes that is charging or discharging the battery. The amount of current will vary depending on the engine speed and the electrical units in use and condition of the battery.

c. Hour-Meter.

(1) The hour-meter indicates the total number of hours the engine has been in operation. The meter is installed with a pressure switch. When the required pressure is reached, the meter will start operating and will continue to operate whether the engine idles or is under full load until the engine is stopped. If the engine hour-meter fails to operate when the engine is running when the oil pressure is normal, and the electrical current to the switch is satisfactory, the trouble is either in the pressure switch or the engine hour-meter. If connecting the two terminals of the pressure switch together with a piece of wire does not cause the hour-meter to operate, replace the defective hour-meter. Otherwise, the trouble is in the pressure switch which should be replaced.

(2) The pressure switch is installed in the oil pressure system by means of a "T" connection near the oil pressure gage, behind the instrument panel. To replace it simply disconnect the connections and install a new switch in its place.

d. Ignition Switch. The ignition or magneto switch has four positions as indicated on the switch. To extreme right—both magnetos off; to the right of center—right magneto on; to the left of center—left magneto on; to the extreme left—both magnetos on.

e. Blackout Switch. The blackout switch is of the push-pull type. It is located on the center left of the panel. To operate the blackout switch, the spring button on the side of the switch must be depressed. The switch has three positions in addition to "OFF." The first operates the blackout light; the second operates the service lights and the third, service stop lights only; the spring button on the side of the switch must be depressed.

f. The Starter, Booster, Compass, and Fuel Cut-Off Switches. These are all toggle switches, and are so indicated.

g. Dash Light Switch. The dash light switch is of the push-pull type, located on the lower left section of the panel.

h. Auxiliary Sockets. Two auxiliary sockets are located in the upper left corner of the panel.

i. Tachometer. The speed of revolution of the engine crankshaft is indicated by the tachometer. It is driven by a flexible, encased shaft connecting to the tachometer drive in the rear face of the accessory case.

j. Speedometer. The speedometer is driven by a flexible shaft connecting from the spiral gear on the output shaft of the transmission. An odometer, which records the tank's mileage, is incorporated in the head of the speedometer.

k. Oil Pressure Gage. This gage records the pressure in the engine oil manifold through a ¼-inch copper tube.

l. Oil Temperature Gage. This gage indicates the engine oil temperature by means of a temperature-sensitive device located on a fitting in the oil pump.

m. The oil dilution valve switch is located directly above the oil temperature gage. An instruction plate giving directions for diluting the oil is located just above the switch.

n. Fuel Gage. A fuel gage, located in the lower left corner of the instrument panel, indicates the amount of gasoline in the sponson tanks. When the toggle switch located above the gage is switched to the left, the gage indicates the amount of gasoline in the left sponson tank. When it is switched to the right, the gage registers the amount of gasoline in the right sponson tank.

o. Fuel Primer. The fuel primer is located on the instrument panel and is discussed in (sec. XV, par. 71).

p. Compass.

(1) DESCRIPTION. A compass is attached to the instrument panel on the lower right side by a bracket. Necessary illumination, controlled by a toggle switch on the instrument panel, is provided by a small lamp. The bulb is accessible for replacement by removing the upper knurled

plug. The two-prong socket at the rear end permits the removal of the compass without disturbing the conduit fastening.

(2) COMPENSATION.

(a) In order to correct or compensate for the attraction of the various metal components near the compass, a means of compensation is provided within the instrument. By removing two screws, the upper lamp holder or shield may be removed, thus exposing the compensating screws. Using the small, brass screwdriver, provided for this purpose, turn the screws until the white dot in the screw slot alines with the white dot on the compass body.

(b) With all equipment of a magnetic nature in place, head the vehicle due magnetic north, as determined by an instrument outside and away from the vehicle (a surveyor's transit may be used.) Turn the "N-S" screw until the compass reads "N". Head the vehicle due west and set the compass at "W" by turning the screw marked "E-W". Head the vehicle due south and remove *one-half* the existing error by turning the "N-S" adjusting screw. Head the vehicle due east and remove *one-half* the existing error by turning the "E-W" adjusting screw.

(c) Recheck by heading the vehicle on the magnetic headings shown on the compensating card and record the corresponding compass readings in the spaces provided.

(d) The compensating card is carried in the deviation card holder, attached to the panel above the compass.

(3) MAINTENANCE. At frequent intervals, inspect the instrument for the appearance of bubbles in the bowl and, if necessary, remove the filler plug and refill with ALCOHOL, ethyl. Compensation for error due to variable magnetic influences should be made whenever such conditions arise.

124. MAINTENANCE OF INSTRUMENTS (fig. 11).

a. All instruments and switches that become inoperative should be replaced.

125. REMOVAL OF INSTRUMENTS (fig. 11).

a. To remove any instrument (except hour-meter) from the instrument panel:

(1) Open the main battery switch.

(2) Remove the nuts holding the wires to the back of the instrument. NOTE: Nuts that hold the wires to the instrument may vary in size on different tanks. Ordinarily, a $\frac{5}{16}$-inch open-end wrench is used to loosen and tighten these nuts, while a small electrical screwdriver is used to loosen the screws on holding clamps.

(3) Remove wires from connections and mark for replacement.

(4) Loosen the screw on the holding clamp that holds the instrument in position on the back of the instrument panel, and remove instrument.

126. INSTALLATION OF INSTRUMENTS.

a. Insert new instrument, dial up.

b. Tighten the screw on the clamp that holds the instrument in position on the back of the instrument panel.

c. Install wires on connections.

d. Install nuts that hold wires to connections.

127. REMOVAL AND INSTALLATION OF HOUR-METER (fig. 11).

a. The hour-meter is held in place on the instrument panel by three screws on the face of the instrument rather than by a holding clamp in back of the panel. Therefore, to remove the hour-meter, use the same procedure outlined in paragraph 125, substituting removal of these screws for the loosening of the screw on the holding clamp. To install hour-meter reverse above procedure.

128. TERMINAL BOX (fig. 59).

a. A terminal box, located in the rear of the engine in front of the left rear engine door, is the terminus for circuits that lead to equipment on the rear of the tank.

129. FUEL CUT-OFF SOLENOID.

a. Fuel cut-off is operated by means of a solenoid controlled by a toggle switch on the instrument panel.

b. When properly installed, the solenoid should not require any attention. If trouble is experienced during normal operation, a heavy jumper placed across the contact terminals will indicate whether the solenoid is inoperative or trouble lies in some other part of the circuit. If the solenoid is inoperative, it is to be replaced.

130. OIL DILUTION VALVE SOLENOID.

a. The oil dilution valve is actuated in one of the two systems by a solenoid. The solenoid is controlled by a toggle switch located on the instrument panel.

b. Under normal operation the solenoid should not require any attention. If trouble is experienced during operation, a heavy jumper placed across the contact terminals will indicate whether the solenoid is inoperative or whether trouble lies in some other part of the circuit. If the solenoid is inoperative it is to be replaced.

131. LIGHTS (figs. 117, 118 and 119).

a. Head Lamps. A socket is provided above each front fender for installation of the combination driving and blackout position lights. The

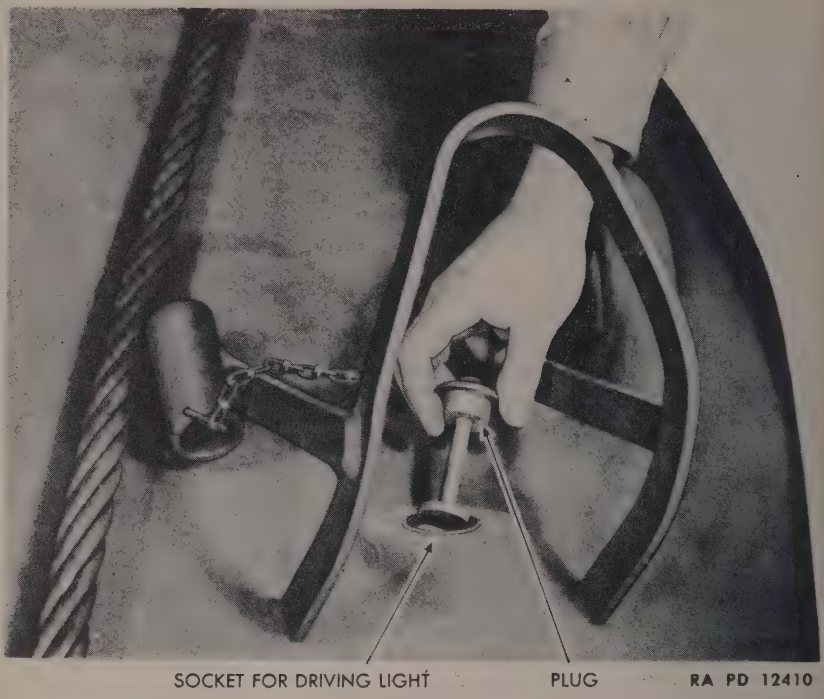


Figure 117—Sealing Driving Light Socket with Weather Plug

lights should be kept in the tank except when specific orders are given by the regimental commander for their use. A plug is provided to weather seal the socket (fig. 117) and should be kept in the socket when the lights are not installed. The plug is chained to a protective housing which is attached to the head lamp guard and in which the plug is stored when not in use.

b. Housing. The driving lights are focused by means of a focusing screw back of the lights.

c. Blackout Hood. A special blackout hood is provided for each driving light.

d. Tail Lamps. The tail lamps are combination lamps. The rear left is a combination stop, service and blackout lamp. The upper lens is the service and service stop light, and the lower lens is the blackout light. In the rear right lamp, the lower lens is the blackout light and the upper lens is the blackout stop light. Both stop lights are controlled by switches connected with the steering hand levers. No stop signaling will be seen unil both hand levers are pulled, indicating a slowing down or full stop.

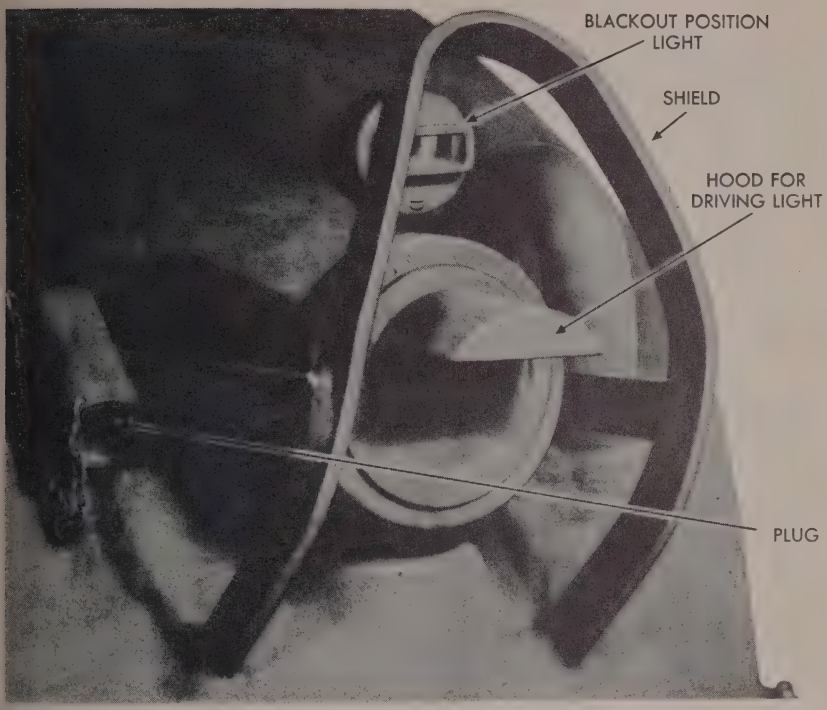


Figure 118—Driving Light with Blackout Hood Attached

132. SIREN (fig. 2).

a. The siren is located on the front left fender of the tank and is operated by a foot button at the driver's left foot. To replace siren:

b. Removal.

(1) Open the main battery switch.

(2) Disconnect the electric cable at fender connector.

(3) Remove the nuts and bolts.

(4) Remove siren.

c. Installation.

(1) Install new siren in place on fender.

(2) Install nuts and bolts.

(3) Connect electric cable at fender connector.

133. IGNITION SHIELDING HARNESS (fig. 65).

a. Description. All parts of the ignition wiring system are shielded to prevent radio interference. The shielding is constructed so that if any

Figure 119—Driving Light with Hood Removed

part is damaged it may be readily replaced without discarding the entire shielding structure. The ends of the conduits are equipped with an elbow which attaches directly to the shielded spark plug and facilitates easy removal.

b. Maintenance and Inspection.

(1) The electrical wiring, the shielding, and conduits require frequent inspection and check.

(2) All crushed shielding and conduits should be replaced. Oily or dirty spark plug shields or shielding fittings should be cleaned and all coupling nuts tightened. Wires and conduits which have become oil-soaked should be replaced.

(3) In cleaning couplings or spark plug shields, a solution of CARBON TETRACHLORIDE should be used. If that is not available, SOLVENT, dry-cleaning, may be used. After cleaning and drying, the threads of each coupling should be cleaned with a small wire brush to remove high-resistance oxidation which sometimes forms on the inside of aluminum couplings.

c. Replacement of Conduits.

WRENCH, leather strap

(1) Loosen the connection between the conduit and the body of the harness, using a leather strap wrench.

(2) Break the connection at the spark plug and remove the conduit.

(3) Hook up the new conduit at the spark plug.

(4) Using a leather strap wrench, tighten the connection that hooks up the conduit to the body of the harness.

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Figure 120—Spark Plug

134. SPARK PLUGS (fig. 120).

a. The spark plugs used on this engine are the regular aircraft type and are radio-shielded.

b. Replacement and Removal.

(1) At the time of the 50-hour check, or whenever spark plug replacement is found necessary, the unserviceable plugs will be replaced by serviceable plugs.

(2) To Remove the Spark Plugs from the Engine.

(a) Lift up the front and then the rear top plates over the engine.

(b) Remove the cable connection with a 5/8-inch open-end wrench. Remove the spark plug from the cylinder recess with a spark plug wrench (1-in. wrench). Due to the various types of plugs used, different sizes of spark plug wrenches may be needed.

(c) Remove inspection plate from bottom of hull under engine compartment.

(d) To facilitate removal of front spark plugs, remove inspection cover plates on fan cowling.

(e) The use of a socket wrench with a universal joint extension facilitates removal of certain plugs whose location makes removal difficult with an ordinary socket wrench.

(f) Five plugs may be removed from the front and five from the rear of the engine by reaching down from the top of the compartment. The remaining plugs can be reached through the opening in the hull beneath the engine.

(3) When installing spark plugs in the engine, do not use wrenches with handles more than 10 inches long. It is possible to distort certain sections of the plug if too much force is used in tightening the plugs in the engine cylinders. Solid copper gaskets are to be used. Apply a thin coating of COMPOUND, antiseize, mica-base, to the threads of all spark plugs before installing.

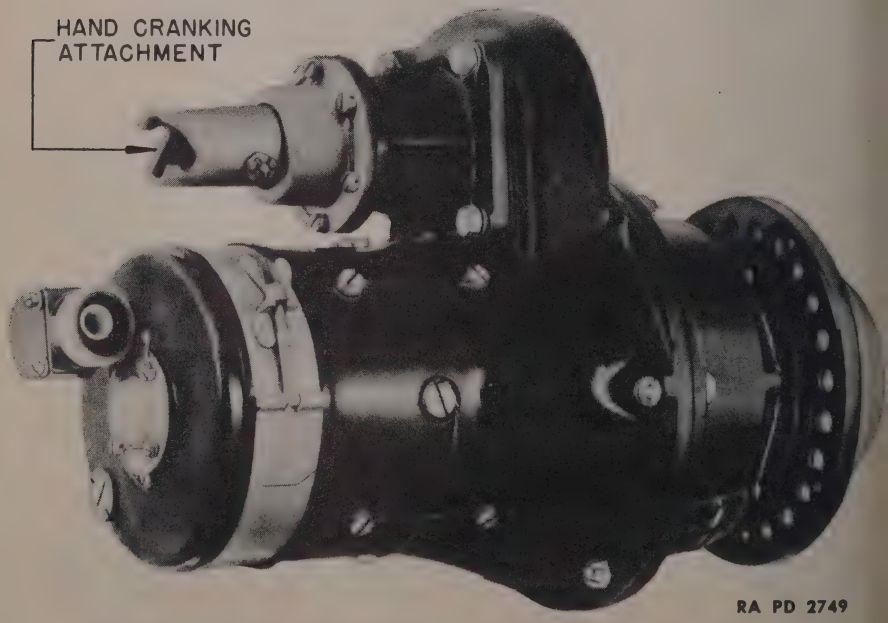

Figure 121—Starting Motor

ELECTRICAL AND IGNITION SYSTEMS

135. STARTING MOTOR (fig. 121).

a. Description. A 24-volt direct electric starter is used on this engine. The switch is located on the instrument panel.

b. Hand Cranking. Provision is made at the top of the starter unit for turning the engine over by handcranking it.

c. Removal. NOTE: If the starter fails to operate properly, it should be replaced.

PLIERS, diagonal-cutting	WRENCH, open-end, $\frac{9}{16}$-in.
SCREWDRIVER	WRENCH, socket, $\frac{9}{16}$-in.

(1) First open the main battery switch.

(2) Remove the terminal guard cover and disconnect cable from the starter switch.

(3) Remove the locking wire or cotter keys and the nuts holding the starter to the accessory case.

(4) Remove the starter.

d. Installation.

PLIERS	WRENCH, open-end, $\frac{9}{16}$-in.
SCREWDRIVER	WRENCH, socket, $\frac{9}{16}$-in.

(1) Install starter in place and install the nuts that hold the starter to the accessory case.

(2) Install the cotter keys or locking wire to secure the nuts.

(3) Install the cable from the starter switch.

(4) Install the terminal guard cover.

e. Lubrication. All starters are sufficiently lubricated at the time of issue and should not require any further lubrication between major engine overhaul periods.

136. MAGNETOS.

a. Description. Dual ignition is furnished by two magnetos mounted on the accessory case. The right magneto fires the front spark plugs and the left magneto fires the rear plugs. The magnetos are equipped with automatic spark advance and shielded to prevent radio interference. The numbers on the magneto ends of the ignition wires correspond to the order in which they fire the spark plugs, and not to the cylinder numbers. Thus the wire to cylinder No. 3 is stamped "2", as it is the second in the cylinder firing order (cylinder firing order, clockwise viewed at magneto and is 1-3-5-7-9-2-4-6-8). The magneto will be one of two different makes, Scintilla or Bosch. Since they require slightly different adjustments, they are treated separately in this manual. Scintilla or

Bosch magnetos identified with green markings are used on engines with blue name plates (model R975C-1). The internal timing has been changed on the Scintilla magneto for the R975C-1 engine, so the same timing procedure can be followed for both engines. The Bosch magneto is used only on the R975C-1 engine.

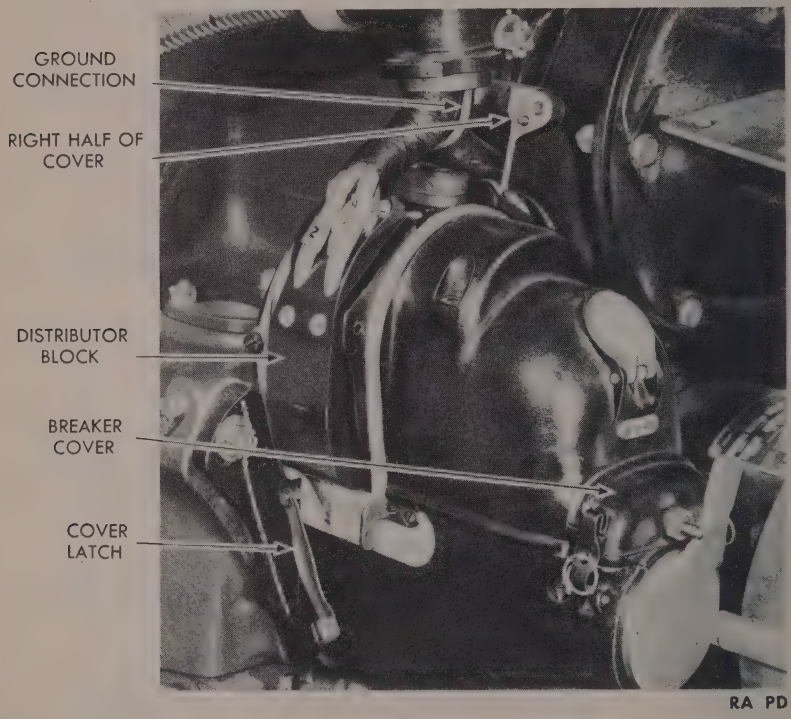

Figure 122—Magneto with Left Half of Distributor Cover Removed

137. ADJUSTMENT OF BREAKER GAP (SCINTILLA) (fig. 123).

GAGE, feeler **WRENCH**, magneto

a. Remove the breaker cover by releasing the safety ring on each side.

b. Using a feeler gage, measure the clearance of the contacts when held wide open by the cam. The engine will have to be turned over with a hand crank to open the magneto contacts to their widest position.

c. Loosen the lock nut on the contact screw, using a magneto wrench.

d. Adjust points by turning the screw until there is 0.012 inch clearance between the contact points on the magneto (feeler gage).

e. Tighten lock nut.

f. Install breaker cover.

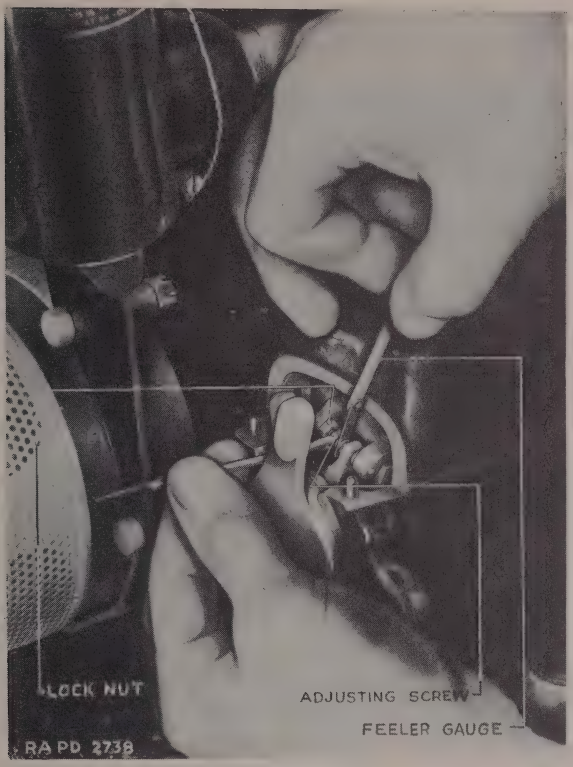

Figure 123—Adjusting Breaker Point Gap on Scintilla Magneto

138. CHECKING MAGNETO TIMING (SCINTILLA) (ENGINE OUT OF TANK).

DISK, timing	POINTER, timing
INDICATOR, top dead center	WRENCH, open-end, 3/8-in.
PLIERS, cutting	WRENCH, spark plug

a. Remove the spark plugs and the rocker box covers from the No. 1 cylinder. Crank engine until No. 1 piston starts on its compression stroke.

b. Install top dead center indicator in the rear No. 1 cylinder spark plug opening (fig. 124).

c. Install timing disk (tool 80292) and pointer. A piece of stiff wire, installed as shown (fig. 125) makes an excellent pointer, if it is stiff enough to hold position.

d. Find top dead center on the No. 1 cylinder by the following steps:

(1) Rotate crankshaft clockwise until the pointer comes up to one of the lines on the dial of the T.D.C. indicator. Mark the line.

(2) Mark the location of the pointer on the timing disk at this point.

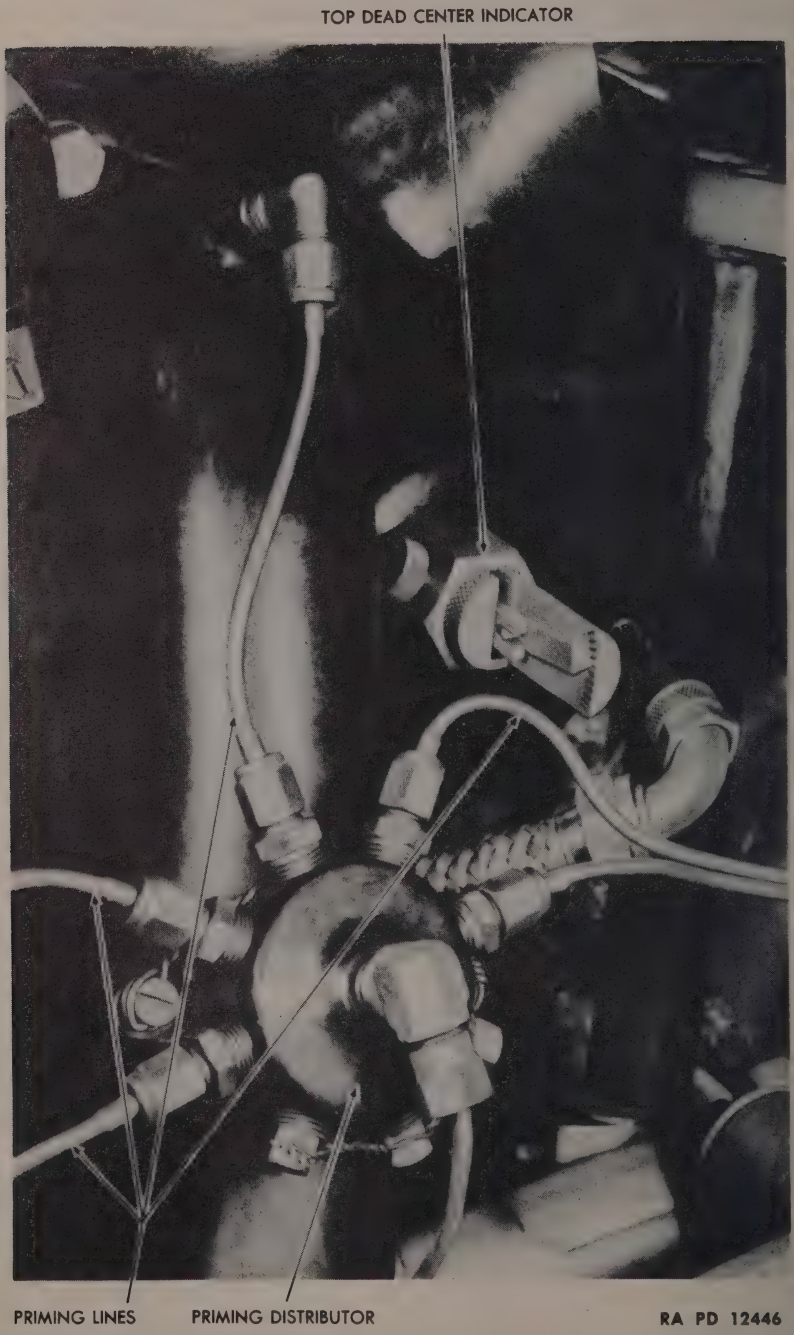

Figure 124—Checking Piston Location with Top Dead Center Indicator

(3) Continue the rotation of the crankshaft until the pointer of the T.D.C. indicator moves to its maximum point and returns to the line marked in step (2).

(4) Mark the location of the pointer on the timing disk at this point.

(5) Move the crankshaft so that the needle points to the line midway between the two pencil marks. The No. 1 cylinder is now at top dead center, so move the wire pointer to zero on the disk.

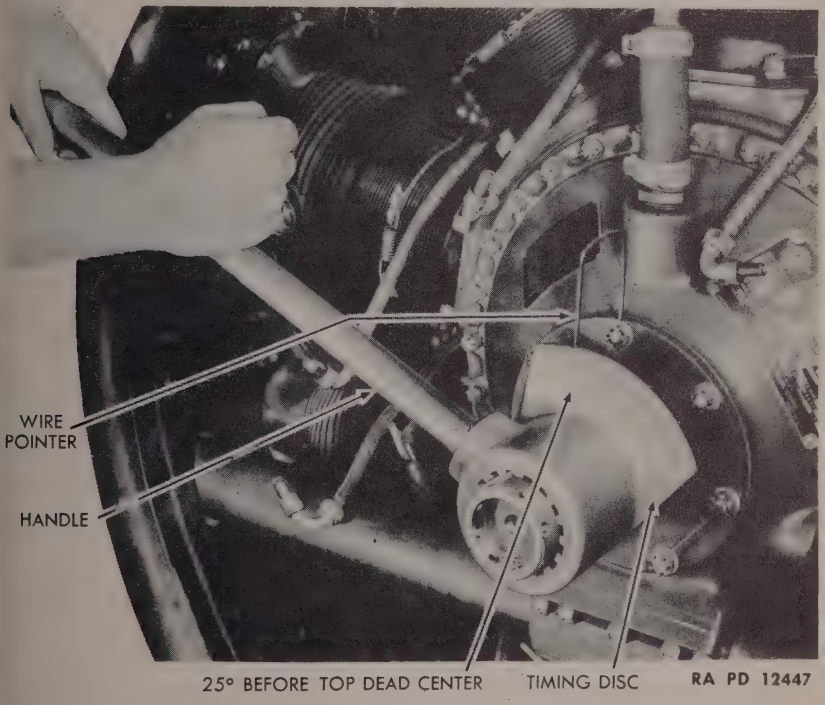

Figure 125—Use of Timing Disk to Turn Engine to a Timing Position

e. Move the crankshaft until the needle points to 29 degrees before top dead center on compression stroke when timing right magneto, and 26 degrees before top dead center when timing left magneto. NOTE: The valve rocker arms will be free when the number one piston is on compression stroke.

f. Remove the cover on the magneto to be checked, by removing the safety pins from the cover latches at the bottom and by removing the bolts and cap screws at the top with a ⅜-inch open-end wrench. Unscrew the ground wire connection from the top of the magneto (fig. 127) also booster secondary wire if on right magneto. Remove the two distributor blocks from the magneto.

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Figure 126—Scribe Marks Indicating Correct Magneto Timing

g. Check the scribe marks on the magneto housing and the distributor gear. If the magneto is properly timed, the single lines will be exactly in line (fig. 126). The double lines on the other side of the magneto will also be lined up. For accuracy they should be checked with a straightedge. If the marks are not exactly in line, loosen the hold-down nuts slightly and tap the magneto to the right or left to secure perfect alinement. NOTE: If the timing operation is in connection with the replacement of a magneto, line up the scribe marks on the magneto before installation, holding the alinement during installation (fig. 127).

h. Tighten the hold-down nuts securely and wire the nuts.

i. Install the magneto ground wire, distributor blocks and covers, and install bolts, cap screws, and latch fastenings.

139. FIELD METHOD OF REPLACING MAGNETO (SCINTILLA) (ENGINE IN TANK) (fig. 127).

PLIERS, diagonal-cutting
SOCKET, ½-in. w/universal extension
WRENCH, open-end, ½-in.

a. Before starting to remove a magneto, remove the distributor blocks, (par. 138 f), and turn the crankshaft until the scribe lines line up. Cut the locking wires.

b. Remove the hold-down nuts which secure the magneto to the accessory case, using a ½-inch open-end wrench on the outer nuts, and a ½-inch socket with universal extension to remove the nut located between the magneto and the generator.

c. Hold the magneto in place while removing the last nut, and then lift off the magneto and gasket.

d. Check the magneto to be installed for 0.012-inch gap, cleanliness of points and output (par. 137).

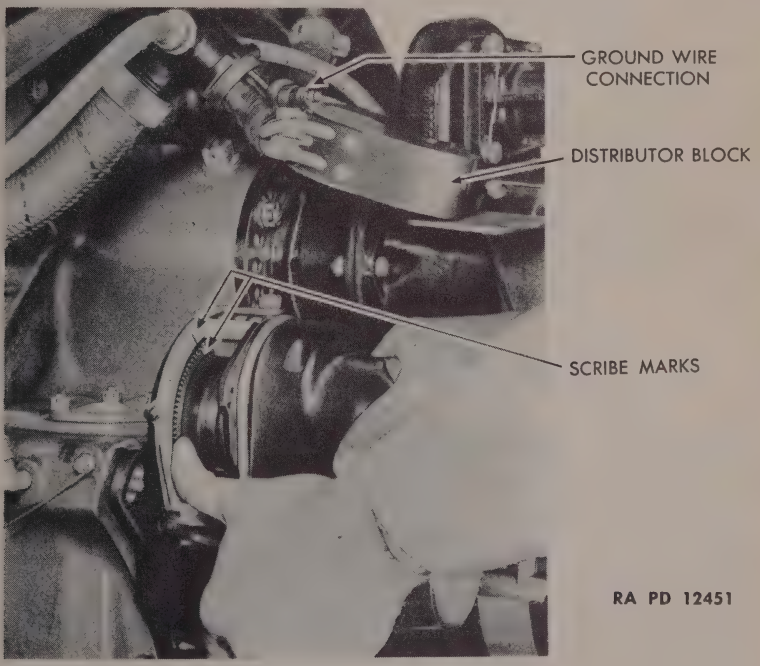

Figure 127—Holding Alinement of Scribe Marks While Installing Magneto

e. Line up the scribe marks in the magneto to be installed and, holding the marks securely in line with thumb, install gasket and magneto.

f. Install hold-down nuts, and, before tightening them all the way down, check scribe lines with a straightedge. CAUTION: Lining up the scribe marks by eye is not sufficiently accurate. To secure exact alinement, tap the magneto to left or right. Tighten hold-down nuts securely and wire the nuts.

g. Reinstall distributor blocks and covers.

MEDIUM TANKS M4 AND M4A1

140. EMERGENCY METHOD OF REPLACING MAGNETOS IN FIELD WHEN POSITION OF NO. 1 PISTON IS UNKNOWN DUE TO ENGINE HAVING BEEN MOVED WITH BOTH MAGNETOS REMOVED.

a. Remove spark plug in No. 1 cylinder and use top center indicator (or screwdriver if no indicator is available). Remove rocker box covers from intake and exhaust rocker boxes on No. 1. Find top dead center of *compression stroke* on No. 1 (*both* valves will be closed).

b. Check magneto for proper point gap (0.012 in.), cleanliness of points, and output.

c. Line up scribe marks on magneto distributor gear and magneto housing and turn distributor gear *in clockwise direction* until points just start to break. This will be about three and one-half to four teeth past the alinement of the scribe lines. (The *distributor gear* rotates in the *same direction as the crankshaft, clockwise,* when magneto is installed on accessory case.)

d. Hold distributor gear with thumbs, with points just starting to open, and install magneto on accessory case. Tap magneto slightly to right or left after installing to obtain exact position with points just breaking.

e. Tighten hold-down nuts and wire, install blocks, covers, and clamps.

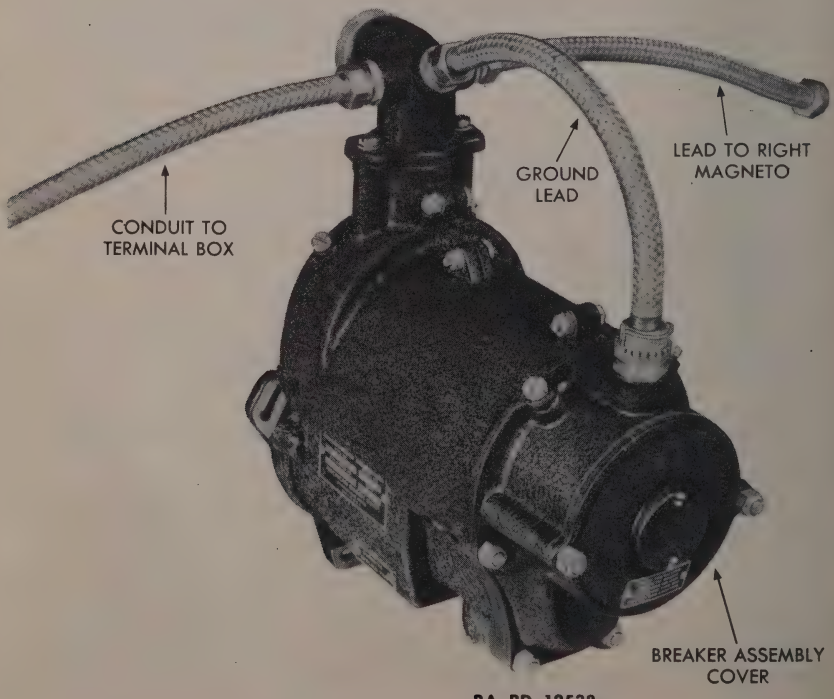

Figure 128—Bosch Magneto Used on Medium Tank M4A1

f. Other magneto may be installed in same manner, or, before replacing blocks on first magneto, turn engine over until the scribe marks line up (approximately two revolutions). Then line up scribe marks on other magneto and install it as in steps four and five of field method. NOTE: Magnetos installed in this manner will be a degree or two out of time, but will serve to run the engine until such time as the engine can be removed and the magnetos properly timed with a timing disk.

141. THE BOSCH MAGNETO.

a. The Bosch magneto furnished on the M4 and M4A1 Medium Tanks differs from the Scintilla magneto in the method of adjusting the breaker gap and in the procedure of checking and adjusting timing. The Bosch magnetos are to be used on the blue name plate engines (R975C-1, only).

142. ADJUSTING THE BREAKER POINT GAP (BOSCH) (figs. 129 and 130).

GAGE, feeler, 0.012 WRENCH, open-end, $\frac{7}{16}$-in.
SCREWDRIVER

a. Remove the two self-locking nuts ($\frac{7}{16}$-in. open-end wrench) that hold the breaker assembly cover to the housing and remove the cover.

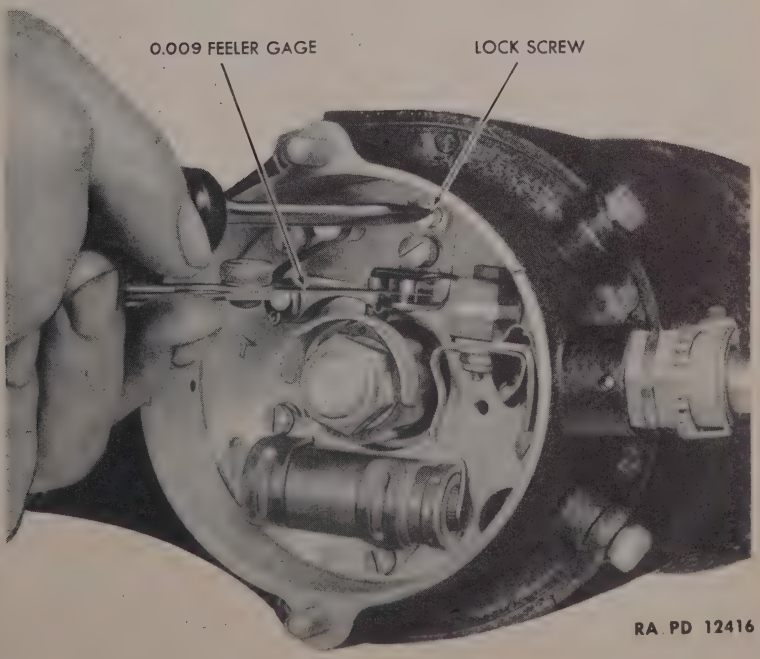

Figure 129—Adjusting Breaker Point Gap on Bosch Magneto

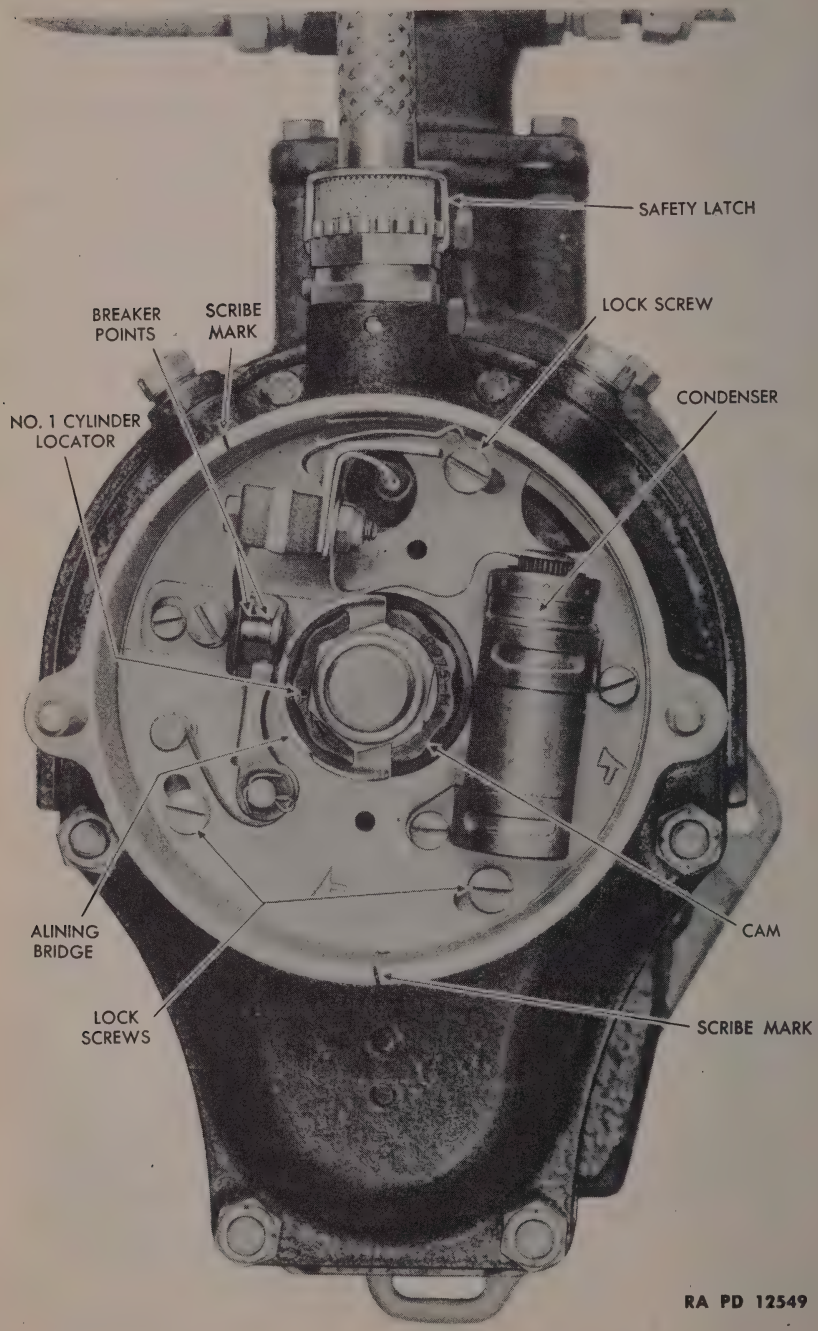

Figure 130—Breaker Mechanism of Bosch Magneto

b. Rotate the cam (by hand if magneto is off the engine, or by using the hand crank if magneto is installed on the engine) until the maximum breaker point opening is reached.

c. Loosen the screw (screwdriver) that holds the breaker point bracket to the housing and with the 0.009-inch feeler gage between the points, set the gap and tighten the screw.

d. Rotate the cam to the next maximum breaker point opening and check the gap. Readjust if necessary.

143. MAGNETO INSTALLATION AND TIMING.

a. Equipment.

SCREWDRIVER
SOCKET, ½-in., with universal extension and handle
WRENCH, 7/16-in.
WRENCH, open-end, ½-in.

b. Procedure.

(1) Remove the four fillister-head bolts that hold the housing cover to the housing (screwdriver) and remove the cover.

(2) Turn the rotor until the white timing dot on the distributor drive gear lines up with the red dot on the housing.

(3) Refer to paragraph 138 **a, b, c,** and **d** to find top dead center of number one piston on compression stroke. Move the crankshaft until the needle points to eight degrees before top dead center when timing right magneto and five degrees before top dead center when timing left magneto. NOTE: The valve rocker arms will be free when the number one piston is on compression stroke.

(4) Holding the distributor gear from turning with the fingers of the left hand, install the magneto in place, tipping it to right or left if necessary, to engage the splines on the magneto drive.

(5) Install and tighten the magneto retaining nuts on the studs by hand. Check the alinement of the timing dots and move the magneto to the right or left, if necessary, to correct alinement. Tighten outside nuts with ½-inch open-end wrench. Use ½-inch socket wrench with universal extension to tighten the nut on the inside stud.

(6) Remove the coil cover (screwdriver), install distributor block in place, and replace field coil cover. The field coil cover should always be removed before removing or replacing the distributor block.

(7) Separate the housing cover into its two parts (7/16-in. open-end wrench) and install the halves in place on the housing. Reinstall the three bolts joining the two halves and install and tighten the harness elbow to the cover (7/16-in. open-end wrench).

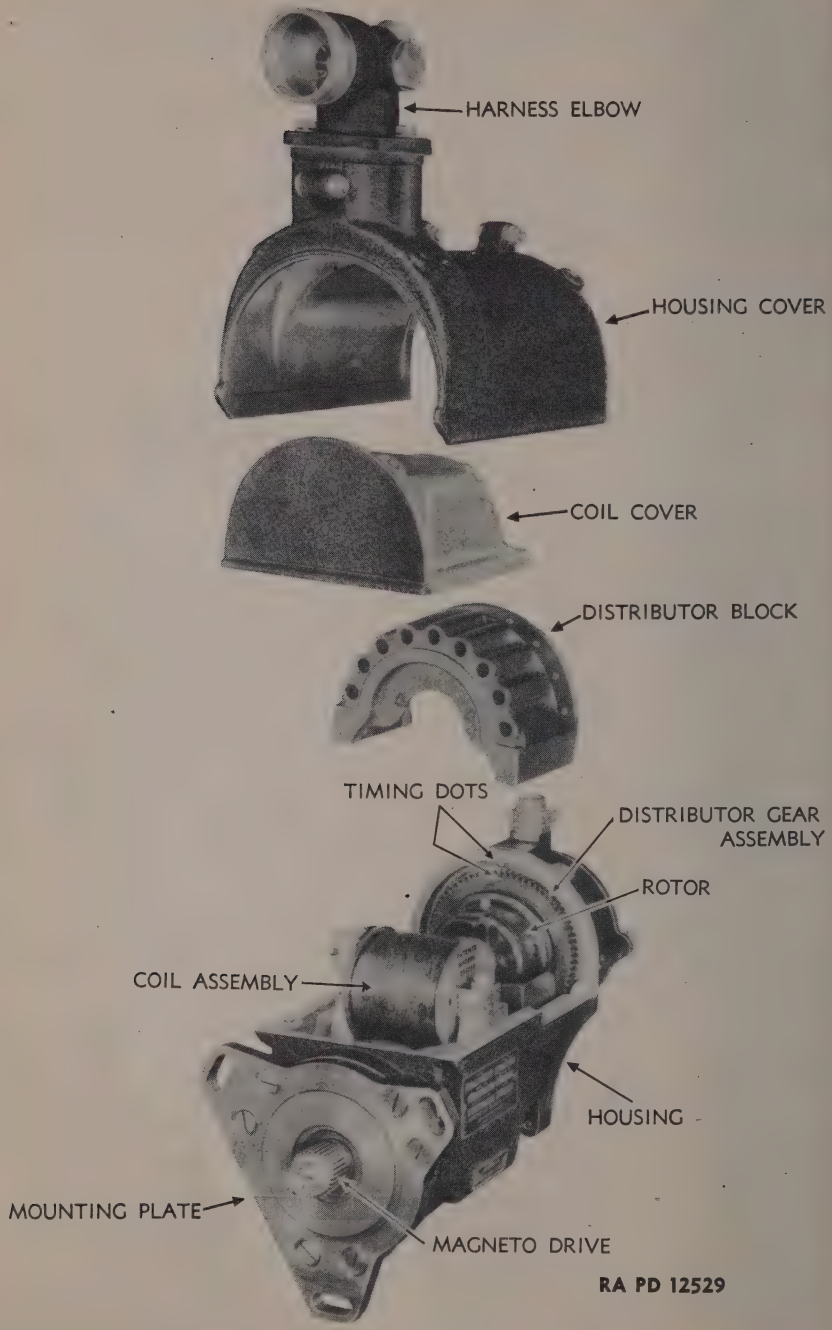

Figure 131—Component Parts of the Bosch Magneto

ELECTRICAL AND IGNITION SYSTEMS

144. BOOSTER COIL (fig. 132).

a. Description. A booster coil is provided for use with the Scintilla magneto which supplies an intense auxiliary spark across the points of the spark plugs to facilitate engine starting. The booster coil switch is located on the instrument panel, and is used to connect the booster coil at starting. NOTE: At time of 100-hour check, or whenever booster coil replacement is found necessary, the unserviceable unit will be replaced with a serviceable one. Disassembly, servicing and adjustment will be done only by ordnance maintenance personnel.

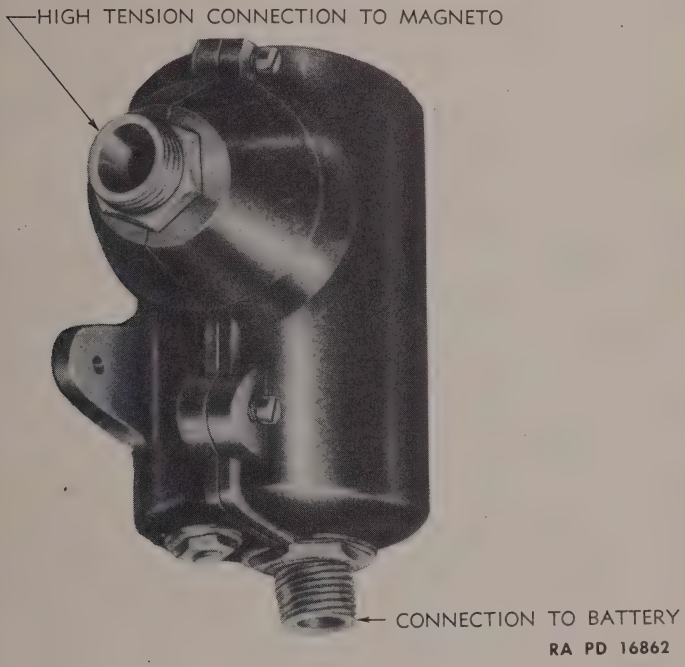

Figure 132—Booster Coil Assembly

b. Removal.

WRENCH, open-end, 3/8-in. WRENCH, open-end, 3/4-in.

Disconnect cables with shielded connection from booster coil. Remove bolts which hold coil to bracket. Remove coil.

c. Installation.

WRENCH, open-end, 3/8-in. WRENCH, open-end, 3/4-in.

Install coil in place. Install bolts which hold coil to bracket. Connect cables.

145. TURRET ELECTRICAL INSTALLATIONS.

a. Description (figs. 133, 134, 135, 136 and 138). Current for all electrical units in the turret is brought in through the slip ring assembly located in the center of the turret basket floor (fig. 133). The upper rings carry the 12-volt current for the radio and interphone system, while the lower rings provide 24-volt current for the traversing and stabilizer mechanisms and the firing switches. All leads from the 24-volt circuits go through the turret switch box (fig. 134). The turret traversing motor operates on 220-volt direct current generated by the motor generator set (fig. 158).

b. Inspecting Slip Rings (fig. 133). The slip ring assembly will seldom require any attention and should be kept tightly covered except during inspection. Slip rings should be inspected for presence of dirt and should be wiped off with SOLVENT, dry-cleaning, if necessary. Brushes should also be inspected and cleaned in the same manner, and the tension of brush springs checked.

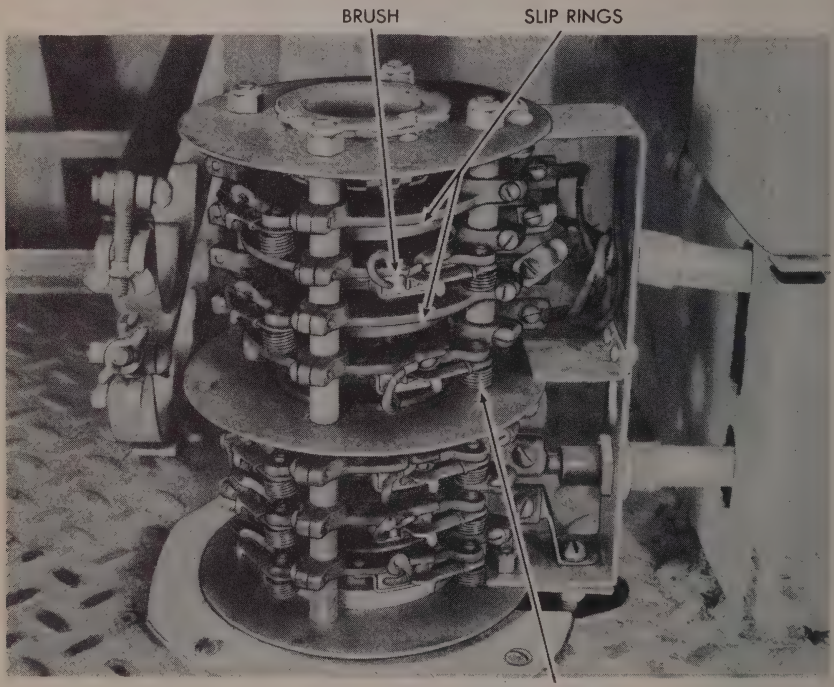

Figure 133—Collector Ring Assembly with Cover Removed

c. Replacing Fuse in Turret Switch Box (fig. 134).

(1) Remove four screws (screwdriver) that hold cover to switch box and remove cover.

ELECTRICAL AND IGNITION SYSTEMS

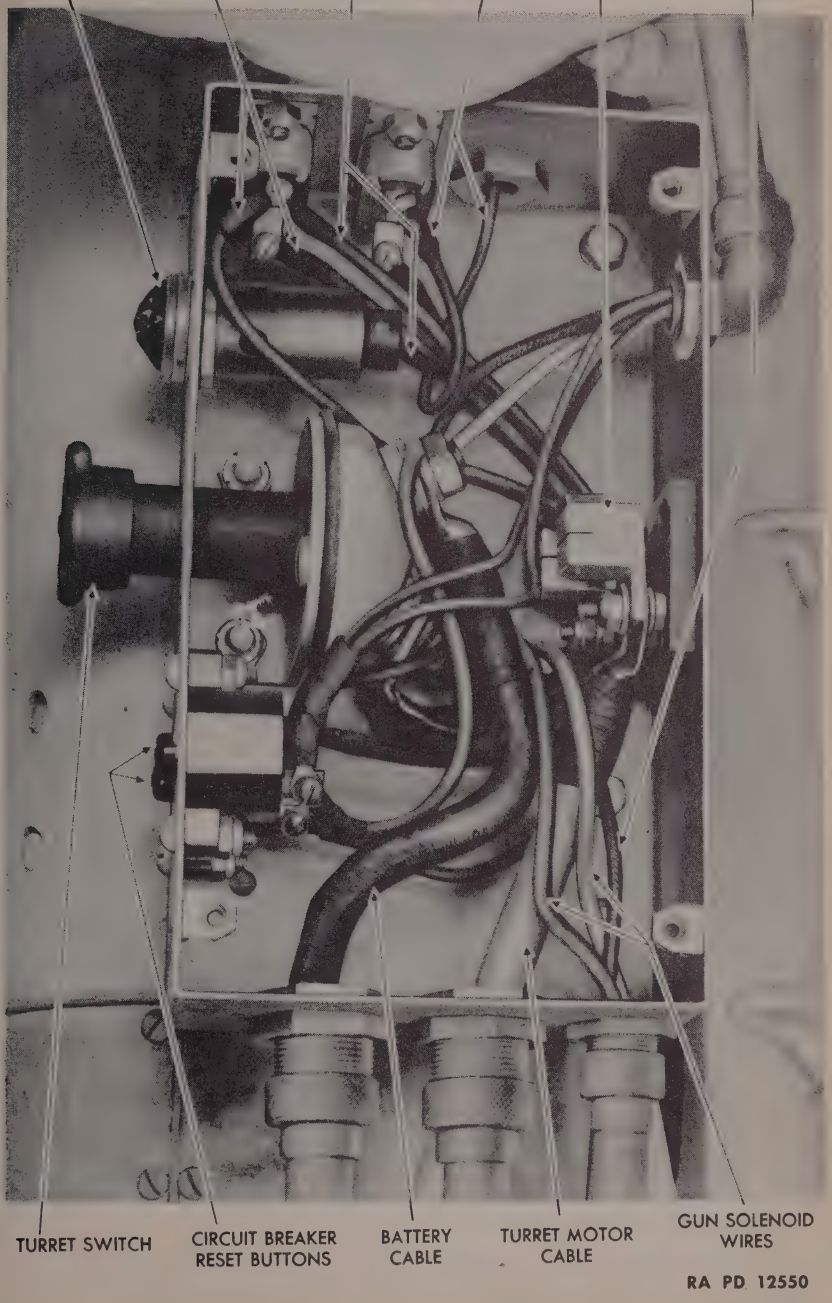

Figure 134—Turret Switch Box with Cover Removed

(2) Loosen two self-locking nuts that hold prongs of fuse assembly and lift out the burned-out fuse.

(3) Slip new 100-ampere fuse into place on the studs and tighten the nuts.

(4) Replace switch cover.

d. Inspecting Firing Solenoids. The firing solenoids on the 75-mm gun and the cal. .30 machine gun should be regularly inspected for security, adjustment and correct operation. If a solenoid fails to operate, check all leads with a test lamp (par. 146 **b**), and if circuit is complete, replace the solenoid. For removal, adjustment and installation of firing solenoids, see paragraph 198.

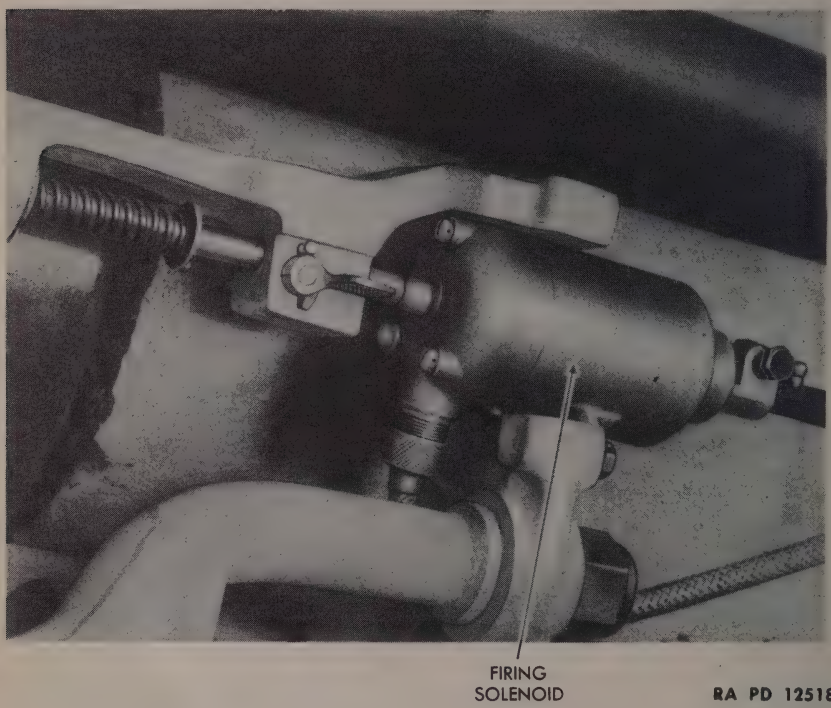

Figure 135—Firing Solenoid Installed on 75-mm Gun

e. Stabilizer and Traversing Mechanisms. No repairs or adjustments other than on those regular controls used in ordinary operation, will be made on any units of the traversing or stabilizer mechanism. Faulty operation traced to any unit should be reported immediately to the proper authority, and the unit replaced (par. 150).

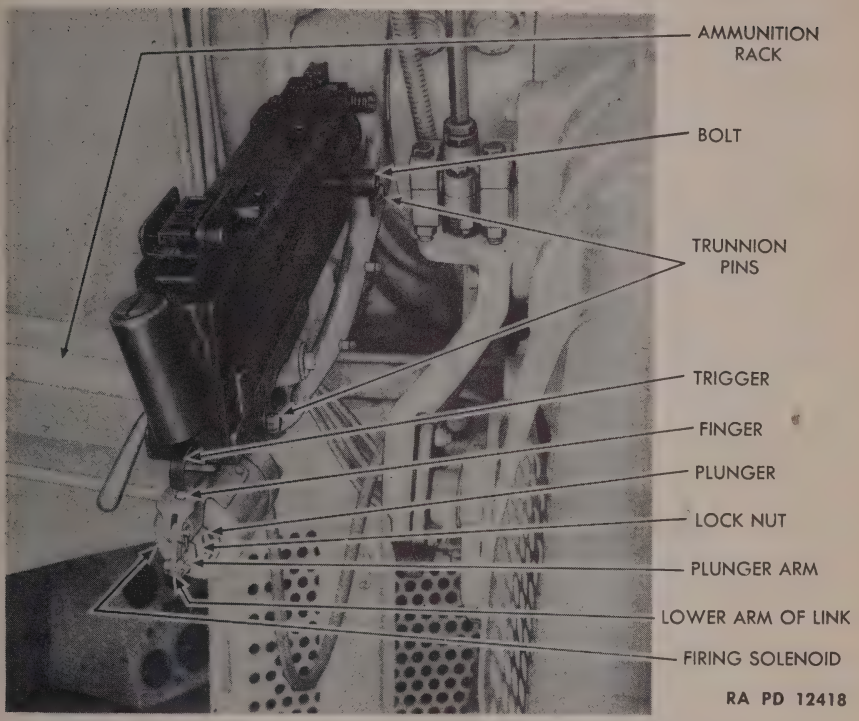

Figure 136—Firing Solenoid on Turret Cal. .30 Machine Gun

146. TROUBLE SHOOTING.

a. General. A major part of the trouble shooting procedure in the electrical system is concerned with checking the wiring to make sure that it is serviceable. All wires that are grounded on the tank or that have open circuits should be replaced with wires of the same size and color.

b. Test Lamp. To test wiring, it is necessary to have a test lamp, which consists of an ordinary 24-volt light such as the instrument panel light, a socket, two pieces of insulated wire (each about 18 in. in length), a clamp, a metal prod approximately an inch long, and tape. Install the lamp in the socket and connect one of the wires to the lead on the socket. Attach the metal clamp to the other end of the wire. Place tape over the connection. Solder the end of the second wire to the side of the socket. To the other end of this wire connect the metal prod and place tape over the connection. NOTE: If a prod and a clamp are not available, scrape approximately an inch of insulation from each of the wires on the ends to which the clamp and the prod should be attached.

If no soldering equipment is available, scrape off several inches of insulation from the end of the wire which should be soldered to the side of the socket; wrap the end around the outside of the socket and place tape over the connection.

c. Jumper. In trouble shooting on the electrical system, it will also be necessary to have a jumper, which can be made by hooking up metal clamps on either end of a piece of insulated wire about 18 inches long. If no clamps are available, scrape off an inch of insulation from each end of the wire.

d. Testing of Wire. To test a wire to determine whether it has an open circuit or whether it is grounded on the tank, use the following procedure:

(1) Disconnect both ends of the wire which are to be tested.

(2) Hook up one end of the test lamp to a live lead and connect the other end to one free end of the wire to be tested. If the lamp burns, the wire is grounded on the tank and should be replaced. If it does not burn, it is not grounded. To determine if it has an open circuit, proceed to the next step.

(3) Take the free end of the wire being tested and ground it on the tank. If the lamp burns, the wire is all right. If the lamp does not burn, the wire has an open circuit and should be replaced.

e. Replacing Wire. To replace a defective wire, use the following procedure:

(1) With the current off, disconnect the defective wire at both ends.

(2) Attach the end of the old wire to the end of the new wire, tying them securely.

(3) Pull the new wire in place by slowly drawing the old wire out.

(4) Disconnect the two wires.

(5) Hook up the new wire at both ends. NOTE: In replacing wire, be sure to install new wire of the same size and color as the old wire. A change has been made in the type and color of wire going from the resistor to the blackout switch; and the terminal block to the resistor. In repairing insulation failures, or at the next tank overhaul period, replace the rubber covered wire with No. 14 green-stranded, asbestos-covered wire in the instances mentioned. When making this change, take the terminal ends from the old lead wires and use them for the asbestos-covered wires.

f. Generator. If the ammeter registers discharge when the engine is being run at 1,000 revolutions per minute and lights and other electrical accessories are on, the generator or generator circuit is faulty. To determine the cause of the trouble, proceed according to the following:

ELECTRICAL AND IGNITION SYSTEMS

(1) With the auxiliary generator unit turned off, run the engine at 1,000 revolutions per minute.

(2) Determine if the circuit from the generator regulator to the battery is good. This is done as follows:

(a) Loosen the quick releasing clamp on the regulator and remove the top of the box.

(b) Connect the test lamp from B+ to B– or A– in the generator regulator box base. If the lamp lights, the fuse and the circuit from the regulator box to the battery are good, and it will be necessary to proceed to step (3). If the lamp does not light, proceed to *(c)*.

(c) Connect the test lamp from the battery lead fuse connection to B–. If the lamp lights, the circuit to the battery is good. Remove and check the fuse. If it is defective, report to the proper authorities. If the lamp does not light, the battery circuit is bad. Determine where it is bad by testing with the test lamp and correct the trouble. NOTE: Most common troubles in the battery circuit are due to corroded cables, loose terminals and an open circuit.

(3) Determine if the generator is supplying current to the generator regulator. This is done as follows:

(a) Connect the test lamp from A+ to ground.

(b) Connect a jumper from A+ and with the other end of the jumper make a momentary connection to the F+ in the base of the regulator. If the lamp lights, the generator circuit is supplying current to the regulator, and, therefore, the units of the regulator are not operating. Report this to the proper authorities. If the lamp does not light, however, the generator circuit is not supplying current to the regulator, and it will be necessary to proceed to step (4).

(4) Restore the residual magnetism in the generator field and retest. Restoring residual magnetism is sometimes called "Flashing the Field" and is done in steps *(a)* and *(b)* following. The retest is done in step *(c)*.

(a) Connect the test lamp from B+ to F+ in the base of the regulator box and allow the lamp to burn for about 10 seconds. CAUTION: Be sure to hook up the test lamp. If this is not done, serious damage to the generator and generator circuit is likely to result.

(b) Repeat steps (3) *(a)* and *(b)*.

(c) If the lamp lights, the fault has been corrected by restoring the residual magnetism in the generator field. If the lamp does not light, the trouble may be located in the circuit from the regulator to the generator, and it will be necessary to continue on to *(d)*.

(d) Check the wiring in the circuit from the regulator to the generator, using a test lamp. If it is defective, replace. If it is good, continue on to step (5).

(5) Determine if the generator is supplying current to the terminal box. This is done as follows:

(a) Disconnect the A+ and F+ leads in the terminal box.

(b) Connect the test lamp from A+ lead to the generator and to the ground.

(c) Connect the jumper to the A+ lead to the generator and with the other end of the jumper make a momentary connection to the F+ lead of the generator. If the test lamp burns, the generator is supplying current to the terminal box, and the trouble is in the wiring between the terminal box and the regulator. The wiring should be tested with the test lamp and defective wire replaced. If the test lamp does not light, it will be necessary to continue on to *(d)*, *(e)*, *(f)* and *(g)*.

(d) Restore the residual magnetism to the generator field by connecting the test lamp from the battery terminal at the regulator to the F+ lead of the generator and allowing the lamp to burn for about 10 seconds.

(e) Connect the test lamp from A+ lead of the generator to the ground.

(f) With the A+ and F+ generator leads in the terminal box disconnected, connect the jumper from the A+ lead of the generator and with the other end of the jumper make a momentary connection to the F+ lead of the generator. If the lamp lights, the trouble has been cleared up by restoring the residual magnetism to the generator field. If the lamp does not light, the trouble may be located in the circuit from the terminal box to the generator, and it will be necessary to proceed to *(g)*.

(g) Using a test lamp, check the wiring from the terminal box to the generator and replace any defective wire. If there is no defective wiring, proceed to step (6).

(6) Determine if the generator is supplying current to its own terminals. This is done as follows:

(a) Disconnect the leads at the generator terminals.

(b) Connect the test lamp from A+ terminal on generator to ground.

(c) Connect the jumper to the A+ terminal on the generator and with the other end of the jumper make a momentary connection to the F+ lead of the generator. If the lamp lights, the generator is satisfactory, and the trouble is in the wiring between the generator and the terminal box. Test the wiring and replace defective wire. If the lamp does not light, proceed to *(d)*.

(d) Restore the residual magnetism of the generator field by connecting the test lamp from the battery terminal in the regulator box to the F+ terminal of the generator and allowing the lamp to burn for about 10 seconds.

(e) Connect the test lamp from A+ on the generator to A– on ground.

(f) With the generator terminals disconnected, connect the jumper to A+ terminal on the generator and with the other end of the jumper make a momentary connection to the F+ terminal on the generator. If the lamp lights, the trouble has been cleared up in restoring the residual magnetism of the generator field. If the lamp does not light, the generator is defective. Remove the generator and replace with a new one and install the generator regulator in its base.

g. Auxiliary Generator. For the auxiliary generator unit, follow the same trouble shooting procedure as on the generator. One additional check must be made if no heat is being put out by the coils. Check the heater switch to make sure it is on and also check the ammeter. If the heater switch is on and the ammeter registers 50, the coils or the coil circuit is faulty. Do not attempt to replace the coils or the circuit. Report to the proper authorities.

h. Voltage Regulator. If the voltmeter goes beyond 28.5 volts, the voltage regulator in the generator regulator has failed. Report to the proper authorities.

i. Ignition Shielding Harness. If static is present in the radio, it is probably due to defective wiring in the ignition shielding harness. Test the wires in the harness and replace any defective wires.

j. Starter Solenoid. If the engine won't turn over, trouble in the starter solenoid or in the starter solenoid circuit is indicated. Check the circuit for defective wires. Check the ground connection on the solenoid for loose ground nuts. Turn starter switch "ON" and bridge the large terminals of solenoid with a heavy jumper wire. If the starter turns the engine, the solenoid is defective and should be replaced.

k. Booster Coil. If the engine will not start, it may be due to failure of the booster. To check, use the following procedure:

(1) One man turns on the booster switch.

(2) Another man goes to the engine compartment and listens for the buzz of the points on the booster coil. If there is no buzz, proceed to step (3).

(3) Check the wiring and booster coil switch. If defective wire or switch is found, it should be replaced. If no defective wire or switch is found, the booster has failed, and it should be replaced.

l. Spark Plugs. If the engine is "missing," it may be due to defective spark plugs. To locate the defective plug or plugs, apply a few drops of oil on the exhaust manifold of each cylinder. Run the engine. On those cylinders that are firing properly, the oil will disappear in a short time. On cylinders where the oil does not disappear quickly, the cylinders are not firing properly, and the spark plugs on these cylinders should be removed and replaced.

m. Magneto. Following is a trouble shooting chart that should be used for locating and cleaning up magneto troubles.

(1) ENGINE FAILS TO RUN ON MAGNETO.

Probable Cause	Probable Remedy
Points not making proper contact.	Clean, check and adjust gap.
Point clearance too large.	Check and adjust gap.
Defective breaker assembly.	Replace magneto.
Defective coil assembly.	Replace magneto.
Shorted primary.	Disconnect switch wire. If magneto operates, the wire to switch, or the switch itself, is grounded. Locate and clear trouble. If magneto does not operate, fault is in magneto. Replace magneto.

(2) SUDDEN ENGINE FAILURE. See (1) preceding.

Ground in switch, or wire to switch.	
Defective breaker assembly.	Replace magneto.

(3) ENGINE WILL NOT STOP.

Broken switch wire.	Shut off gasoline. Disconnect switch wire and ground out magneto. Replace switch wire.

(4) LOSS OR NO POWER (POOR SPARK).

Timing to engine not correct.	Retime to engine.
Magnets weak.	Replace magneto.
Magneto internal timing incorrect.	Replace magneto.

(5) ROUGH IDLING.

Timing to engine not correct.	Retime to engine.

(6) MISFIRING AT LOW SPEEDS.

Breaker gap too large.	Check and adjust gap.
Magneto dirty.	Replace magneto.
Improperly adjusted.	Replace magneto.
Loose connections.	Make proper connections.
Weak magnets.	Replace magneto.
Other internal defects.	Replace magneto.

(7) MISFIRING AT HIGH SPEEDS.

Breaker gap too small.	Check and adjust gap.
Defective breaker assembly.	Replace magneto.
Internal defects.	Replace magneto.

n. General Trouble Shooting. If, when the switch for any electrical unit is turned on, and the unit does not work, there is a general trouble shooting procedure that can be followed.

(1) Check the battery switches to make sure they are closed.

(2) Depress the starter and watch ammeter and voltmeter to make sure current is coming from the battery. If the ammeter does not show a discharge, the battery may need to be charged or replaced.

(3) Push the circuit breaker button that completes the circuit of the unit on which the test is being made. If this does not cause the unit to operate, proceed with next step.

(4) Check with test lamp at terminals of unit to determine if electric current is flowing to the unit. If current is at the unit the wiring is satisfactory, and the unit is at fault and should be replaced. If electric current is not at the unit, check the line at other spots to determine where the open circuit is.

147. DESCRIPTION AND USE OF RADIO SETS.

a. These medium tanks may have installed either the SCR-508, SCR-528 (fig. 137), or SCR-538 radio set. These are all high-frequency, voice-operated sets, with simple controls, and do not require a technically trained operator. The SCR-508 consists of a transmitter and two receivers, which may operate at the same time on different channels; the SCR-528 has a transmitter and one receiver, and the SCR-538 has just one receiver.

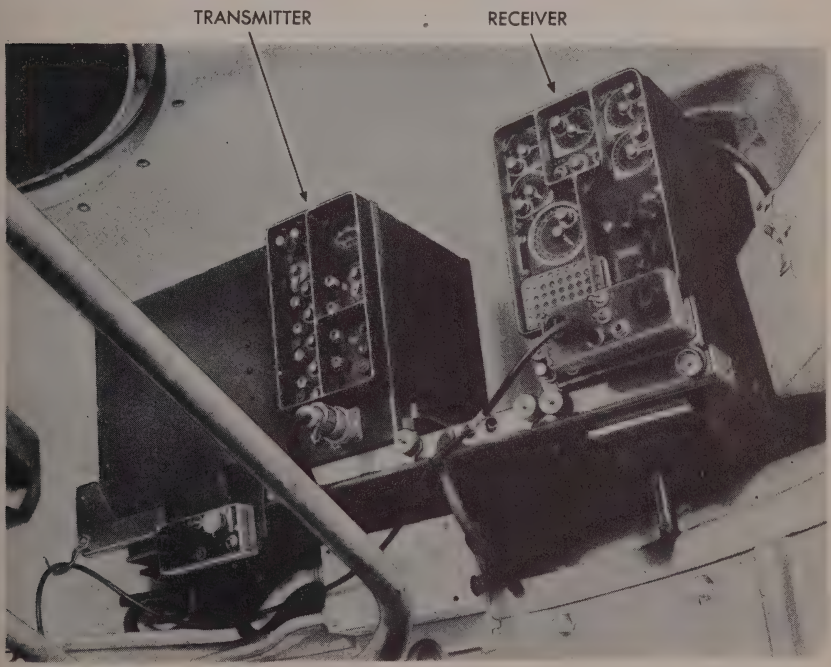

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Figure 137—Typical Radio and Interphone Installation, in Turret (SCR-528 Shown)

Because the interphone system amplifier is a part of the transmitter, the SCR-538 has a special interphone system amplifier. There is an interphone position for each man in the tank, with which he may talk to any other man (fig. 138). These sets will operate reliably from 10 to 15 miles, but are considerably affected by terrain and directional effect of the antenna.

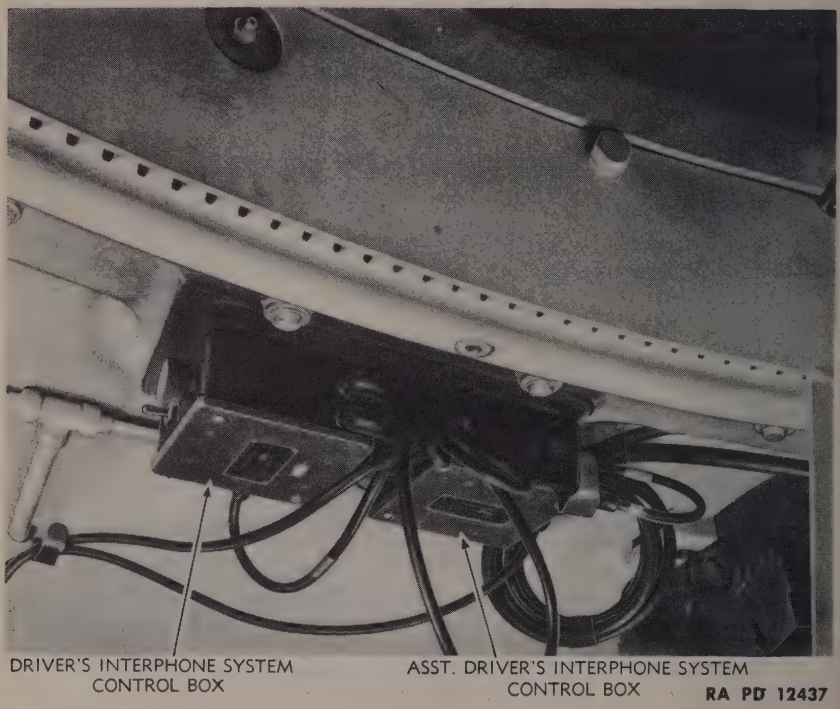

Figure 138—Interphone System Control Boxes for Driver and Assistant Driver

b. The SCR-508 type of set has 10 pre-set channels, any one of which may be readily selected by depressing a push button. The only controls on the transmitter for the operator, other than the push buttons, are the "ON-OFF" switch and the Radio-Interphone system switch. The receiver has, besides its push button tuning controls, a set "ON-OFF" switch, a manual tuning button and dial, a switch for turning the loudspeaker on or off the interphone control switch, and the "Squelch ON-OFF" switch and sensitivity control. The "Squelch" circuit is used to eliminate noise in the set when no signal is being received, and to actuate the call signal.

c. No danger to the operator exists in the use of these types of sets.

However, ordinary precautions must be taken, such as repair of frayed cords or battery leads. The set must be completely turned off whenever changing fuses or tubes. The operator should not attempt anything but first echelon maintenance: keeping the set, headsets, and microphones clean, and external wires tight.

d. Under certain circumstances, such as in a tank group (medium) headquarters, an SCR-506 may be installed in an M4 or M4A1. This is a medium power, CW set requiring a trained operator to tune and operate it.

MEDIUM TANKS M4 AND M4A1

Section XXIII

AUXILIARY GENERATOR

	Paragraph
Care	148
Maintenance	149

148. CARE.

a. The auxiliary generator should be given the same care as any other vital part of the engine or tank. While some inspections are covered in Periodic Inspections, sec. XIII, it is highly important that these inspections be supplemented by those outlined in paragraph (149).

149. MAINTENANCE (figs. 139 and 140).

a. 50-Hour Check.

OIL, engine, SAE 30
SCREWDRIVER
SOLVENT, dry-cleaning
WRENCH, deep socket, $1\frac{1}{16}$-in.
WRENCH, socket, $\frac{7}{8}$-in.

(1) REPLACE SPARK PLUG. To replace the spark plug, remove the cap from the spark plug shield and take out plug with an $1\frac{1}{16}$-inch deep socket wrench. Check the new plug for a 0.025-inch gap. Note that in replacing the plug, the copper gasket goes outside the metal shield surrounding the plug.

(2) REMOVE AND CLEAN BOTH SIDES OF SPARK PLUG ADAPTER. The adapter frequently comes out with the spark plug. Whenever a plug is removed, it should be taken out ($\frac{7}{16}$-in. sock wrench) and thoroughly scraped on both sides to remove all carbon, brownish lead deposits, and loose particles. Always replace gasket when reinstating the adapter.

(3) Clean air filter on carburetor by removing it, disassembling it (screwdriver) and rinsing the parts in SOLVENT, dry-cleaning. Dip the upper end of the screen in clean OIL, engine, SAE 30 or 40. Reassemble and reinstall on carburetor.

(4) Clean carburetor fuel strainer by removing the screen from the fuel inlet connection on top of the carburetor bowl and rinsing it in SOLVENT, dry-cleaning.

(5) Remove and clean the screen in the top of the fuel filter sediment bowl.

b. 100-Hour Check.

CLOTH, dry
FLASHLIGHT
GAGE, feeler
SANDPAPER, fine (00 to 8/0)
SCRAPER, carbon
SCREWDRIVER
STONE, smooth carborundum
WRENCH, Allen, ¼-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.

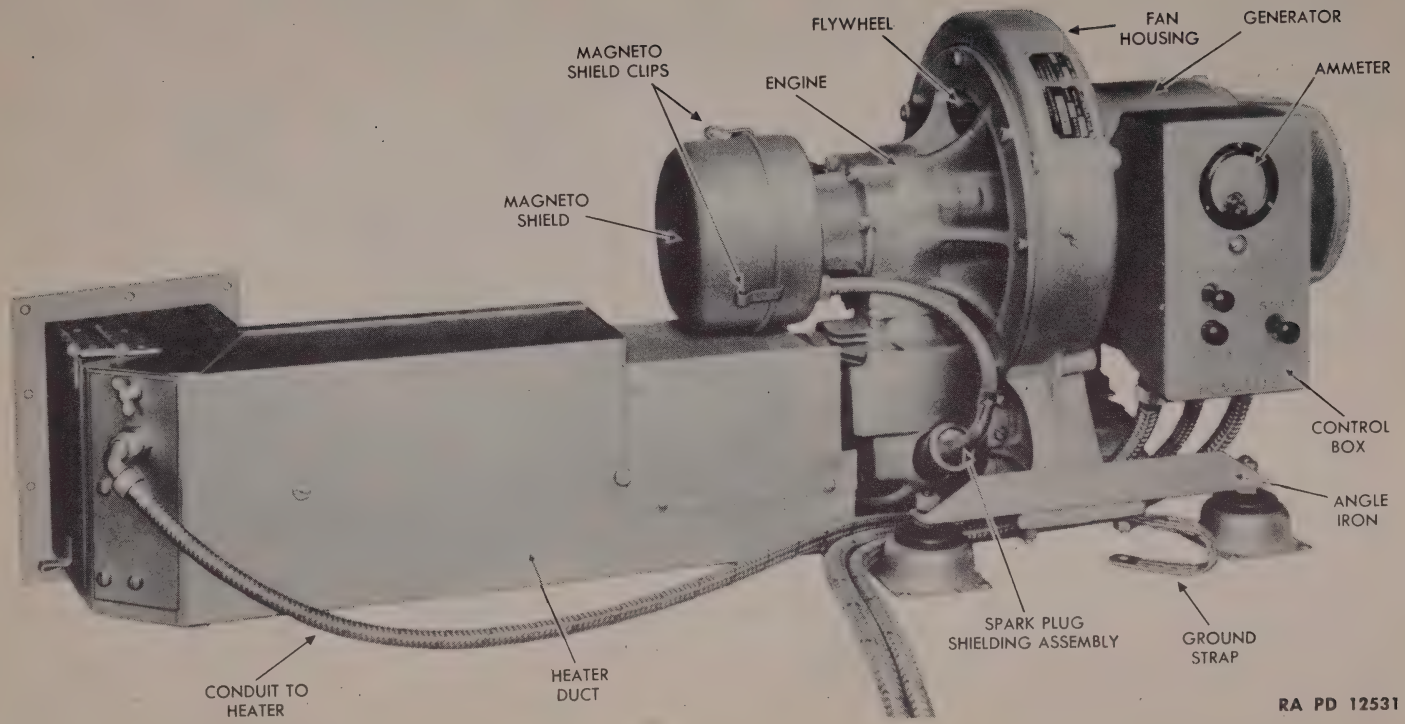

Figure 139—Front View of Auxiliary Generator

Figure 140—Rear View of Auxiliary Generator

(1) Replace the spark plug adapter.

(2) Check the cylinder for carbon. To do this, it is necessary to remove the duct assembly, first removing the duct cover (screwdriver); second, disconnecting the exhaust coupling at the cylinder (four socket-head cap screws; ¼-in. Allen wrench); third, removing the heater assembly (loosening wing nut); fourth, disconnecting the exhaust coupling at the muffler (screwdriver); and fifth, removing the eight cap screws holding the duct to the engine bulkhead and the two cap screws fastening the duct to the sponson. After removing the duct, inspect the ports, using a flashlight. Carbon formation projecting as much as ¼ inch down from the *top* edge of the ports does not materially affect the power of the engine. If carbon deposits are forming *below* the port, the cylinder should be sent to ordnance for thorough cleaning. Otherwise, remove the spark plug and baffle and, using the special carbon scraper, thoroughly scrape the cylinder head to loosen all deposits. To remove the loose pieces, depress the starter button, and crank the engine for about 10 seconds. Check with scraper to be sure that *all* loose pieces have been removed.

(3) CHECK THE MAGNETO POINTS. The only adjustment on the magneto is at the contact point assembly, which should be inspected every 100 hours of operation of the auxiliary generator to see that the gap is exactly 0.020 inch. To adjust, proceed as follows:

(a) Pry open the three clips on the shield over the magneto with a screwdriver and take off the front half.

(b) Remove the magneto rotor by loosening the rotor puller nut. NOTE: Do not remove the three screws holding the starting plate to the rotor as the contact points are then exposed.

(c) Remove the spark plug as in the instructions above, to relieve compression and permit turning the flywheel.

(d) Rotate flywheel until gap reaches its maximum opening. Check gap with feeler gage.

(e) If it is necessary to adjust the gap to 0.020 inch, *slightly loosen the screw* which fastens the contact point assembly to the stator plate, and move the entire breaker mechanism toward the cam to increase the gap, or away from the cam to decrease the gap.

(f) Tighten the contact point assembly, fastening screw securely, and recheck the gap with a feeler gage. Readjust if necessary. Tightening of the set screw sometimes changes the adjustment.

(g) The entire contact point assembly pivots on the breaker lever bearing pin, which permits adjustment of the gap without altering the relationship between the contact point surfaces. If the breaker cam is removed from the intake valve shaft, replace with the arrow (indicating rotation) on the outside.

(h) Uneven or pitted contact points may be restored to a true, even condition, by the use of a smooth carborundum stone, after which all dust particles should be removed with a dry cloth. However, if points are in this condition a new set is recommended. *Do not use a file on the contact point surfaces.* Stiff paper or cardboard will remove the oxide formation which results from long idleness.

(4) CHECK GENERATOR COMMUTATOR.

(a) To inspect the commutator, remove the accessible brush head cover plate with an offset screwdriver. The commutator should require no cleaning for several hundred hours of operation. It need be cleaned only when excessively carbonized.

(b) To clean the commutator, start the engine and place a strip of PAPER, flint, 00 to 8/0 (not emery), on the commutator and hold down with a stick of wood until the commutator is bright.

c. Removing the Unit from the Tank. Should replacement of the unit be required, it is removed from the tank by the following steps:

(1) Open the main battery switch.

(2) Remove the duct cover (screwdriver).

(3) Disconnect the exhaust coupling at the cylinder (4 socket-head cap screws; ¼-in. Allen wrench).

(4) Close the shut-off cock on the fuel filter and disconnect the fuel line at the carburetor (½-in. open-end wrench). This removes the fuel line and screen.

(5) Remove the control box from the generator as follows:

(a) Unscrew the three black knurled buttons and lock washers; remove the screw (screwdriver) below the ammeter and remove the cover, allowing it to hang by the inside connecting wires.

(b) At the terminals in the control box disconnect the three wires that come through the back of the box from the generator yoke. The grommets on the wires can best be lifted from the terminals with a pair of pliers. Before removing the wires, make note of their location to assure correct installation on reassembly.

(c) Remove the two screws (screwdriver) holding the box to the generator yoke (just above the fiber panel), taking care not to drop the screws and washers back of the panel board. If any are accidentally dropped, see that they are removed before assembling, to avoid the possibility of a short circuit.

(d) Push the three wires, previously disconnected from the terminals, back through the hole in the box, and remove the control box. Since any repairs to be done on the control box can be made in the tank, it is ordinarily unnecessary to remove it from the tank with the balance of the unit.

(6) Remove the four bolts (½-in. open-end wrench) which fasten the fan housing to the angle iron supports. Fan housing will drop down onto sponson.

(7) Take off the nut (⅝-in. open-end wrench) on the front end of the right angle iron and swing the angle away from the unit to facilitate removal.

(8) Lift unit out of tank.

d. Installation of Unit in Tank. The unit is installed back into the tank with the following steps:

(1) Set the unit in place and, lining up the bolt holes in the fan housing with the angle iron supports, install the bolts (⅝-in. open-end wrench). It will be necessary to have an assistant help in lining up the holes in the left angle iron, by lifting and moving the unit with a pry.

(2) Reinstall the control box and cover, being sure to install the three wires on the correct terminals.

(3) Connect the fuel line at the carburetor and open the shut-off cock on the fuel filter.

(4) Put the gasket in place on the exhaust port of the cylinder and install and tighten the exhaust coupling.

(5) Replace the duct cover.

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Section XXIV

STABILIZER SYSTEM

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150. TROUBLE SHOOTING.

a. If the gun does not fluctuate to any appreciable extent above or below the horizon, the stabilizer is operating satisfactorily. If the gun does not operate satisfactorily, proceed as follows:

(1) Check the oil level in the oil reservoir, which should be at least two-thirds full at all times.

(2) Check for air in the oil system.

(3) Check the tank voltage which must be maintained between 24 and 28 volts.

(4) Check for excessive friction in the gun mounting and unbalance in the gun.

(5) Check the external electrical connections for looseness or broken wires. Resolder loose connections and replace defective wiring.

(6) Check for lost motion between the gyro control and the hand wheel. If necessary, adjust gear box (par. 158).

(7) Check for loose mounting between gyro control, mounting bracket, and gun. Tighten all mounting bolts and screws.

(8) Check for excess looseness in the cylinder pivot pins and tighten if necessary.

(9) Check lubrication and, if necessary, add grease to the fittings on the stabilizer equipment and the turret assembly.

(10) If there is excessive oil leakage around the piston rod, replace piston and cylinder.

(11) Check the location and operation of the disengaging and recoil switches.

(12) Check clutch and replace parts, if necessary.

b. One of the most common causes of unsatisfactory operation is the condition commonly called "hunting." This may be a vigorous vibration of the gun or a slow movement up and down. Many of the above mentioned conditions will cause "hunting," the most common ones being air in the oil system, looseness in cylinder pivots, loose gyro control mounting, lost motion in gear box worm or worm bracket, excess friction in trunnion bearings, and high voltage.

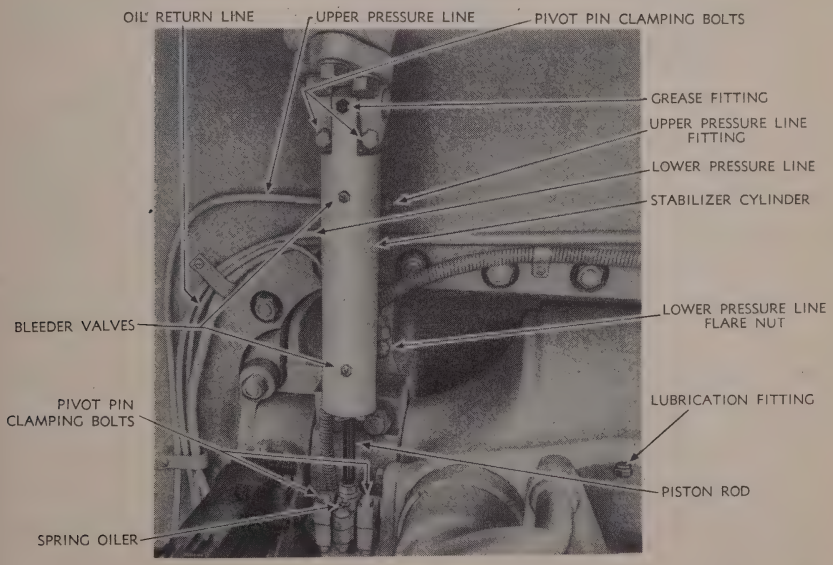

Figure 141—Stabilizer Piston and Cylinder

c. If the trouble has not been corrected after the above checks, replace the various components in the following order, until the source of trouble is found: Gyro control, oil pump, piston and cylinder, recoil switch, disengaging switch, control box, and pump motor.

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151. CHARGING WITH OIL.

a. When charging the system with oil, it is very important for proper operation of the stabilizer that all air trapped in the system be removed. The following procedure, therefore, must be adhered to:

b. **Equipment.**

CAN, oil, pump-type
OIL, hydraulic
WRENCH, box, 7/16-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.

c. **Procedure.**

(1) Throw oil pump switch to "OFF" position.

(2) Use OIL, hydraulic (Univis No. 47, Gov't Spec. 2-79-A).

(3) Heat oil to 150 F to 200 F if possible.

(4) Oil may be poured directly into the reservoir or pumped in with pump-type oil can by removing the filler plug, or it may be added under a small amount of pressure. To get this pressure, proceed as follows:

(a) Provide a filler can with three-foot feed line, shut-off valve at reservoir connection end, and 3/8-inch union below shut-off valve.

(b) Remove oil supply line from reservoir (7/8-in. open-end wrench).

(c) Connect filler can feed line to oil reservoir line.

(5) Make certain that the turret switch is in the "OFF" position.

(6) Loosen the oil return line (3/4-in. open-end wrench), remove small hexagon plugs (5/16-in. open-end wrench) and loosen two bleeder valves on cylinder (5/16-in. and 3/8-in. open-end wrenches) (fig. 142). The 5/16-inch wrench for the top valve and the 3/8-inch wrench for the bottom.

(7) Add oil to system until a flow, free of bubbles, is obtained from the return line. Tighten this connection permanently (3/8-in. open-end wrench).

(8) After a solid flow of oil is obtained from bleeder valves, tighten finger tight.

(9) Loosen top bleeder valve. Push breech slowly to extreme "up" position and tighten bleeder valve after a solid flow of oil is obtained.

(10) Loosen lower bleeder valve. Push breech slowly to extreme "down" position and tighten bleeder valve after a solid flow of oil is obtained.

(11) Repeat steps (9) and (10).

(12) Remove pressure supply line and connections, if used, and reconnect oil reservoir supply line.

(13) Work gun up and down slowly until no more signs of air appear in oil reservoir.

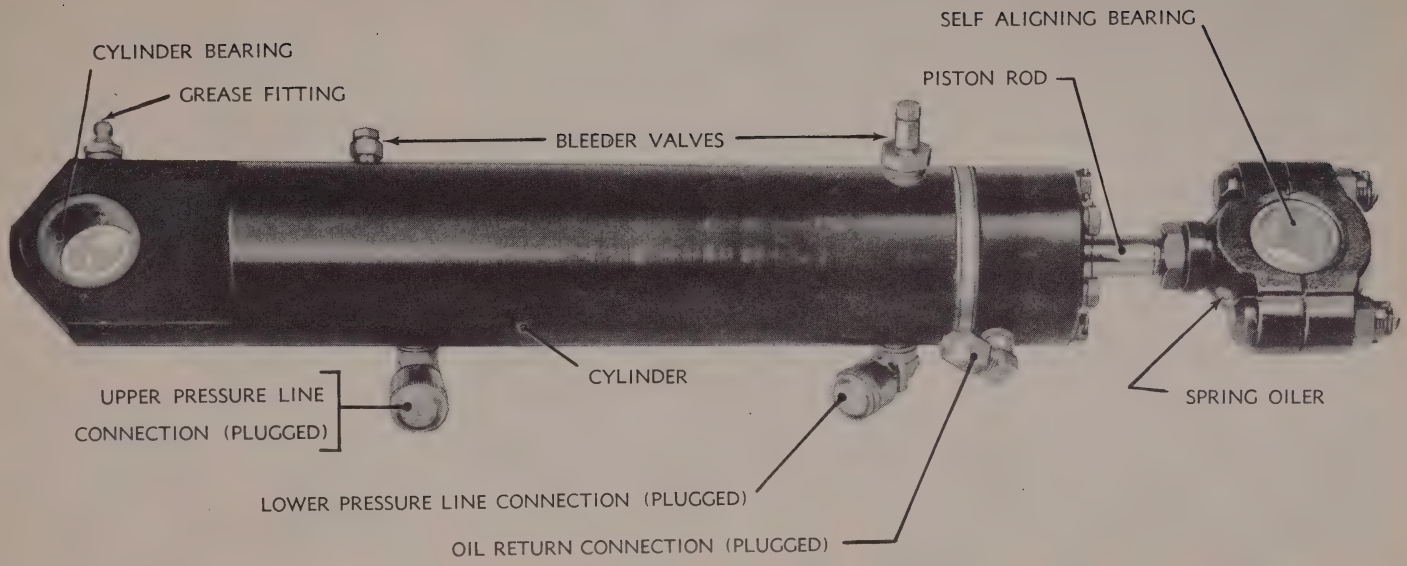


Figure 142—Stabilizer Piston and Cylinder—Removed

(14) Run the pump approximately 10 minutes.

(15) Loosen both bleeder valves with pump running.

(16) After a solid flow of oil is obtained, tighten both valves permanently and stop motor.

(17) Recheck and fill oil reservoir approximately two-thirds full ($\frac{7}{16}$-in. box wrench).

152. REMOVING AIR FROM SYSTEM.

a. To determine if the system is free of air:

(1) Lock gun in fixed position.

(2) Turn turret switch "ON." If oil level drops, there is air in the system.

b. To remove air trapped in the system, turn the turret switch to the "OFF" position, disengage hand elevating mechanism and work gun slowly up and down from 5 to 10 minutes. Then repeat the check in a above. If air still remains trapped in system, repeat purging procedure (par. 151 b, (9) through (11)).

153. MAINTENANCE.

a. The incorrect adjustment or defective operation of any part of the stabilizer will cause unsatisfactory operation of the equipment as a whole. It is therefore essential that the operating instructions be carefully read before attempting to install, operate, adjust, or repair any part of the stabilizer.

154. OIL LEVEL.

a. The oil reservoir should be approximately two-thirds full of OIL, hydraulic (Univis No. 47, Gov't Spec. 2-79-A) at all times. If the oil level drops from day to day, check for leaks in the system.

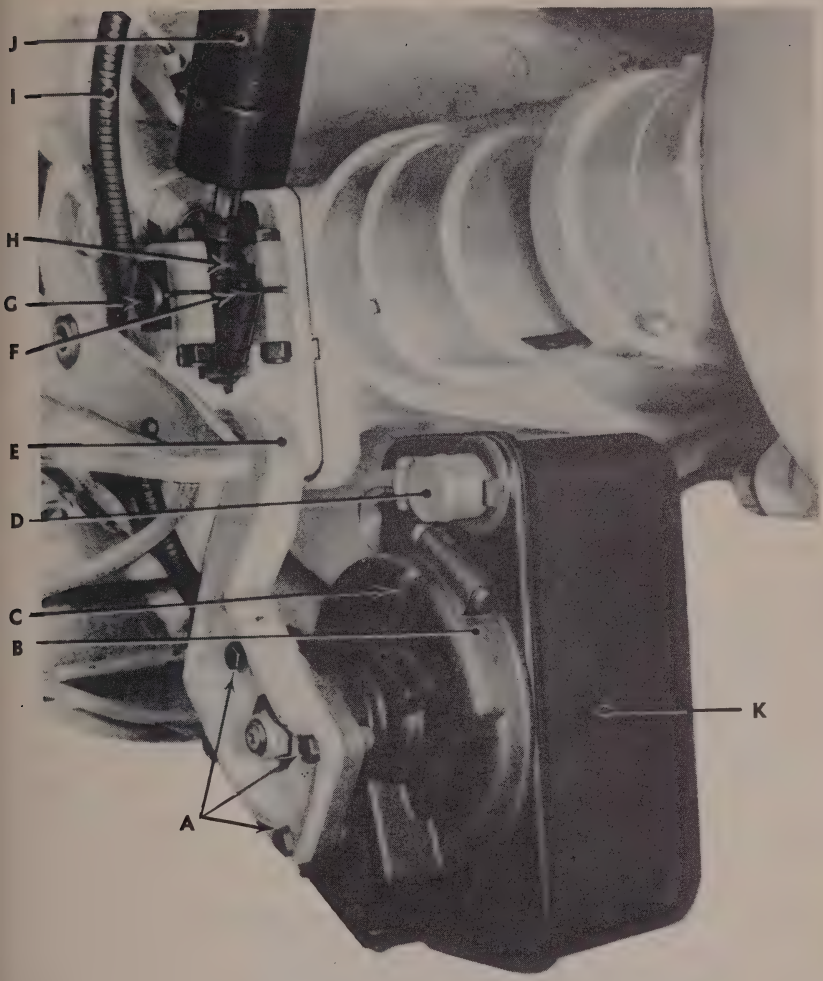
155. LUBRICATION.

a. One Zerk type grease fitting and two spring oilers are provided on those parts of the equipment that require periodical greasing and oiling. One spring oiler is located on the piston rod end (figs. 141, 142, and 143) and the other on the gyro control gear box (fig. 143). The grease fitting is located on the cylinder. Grease and oil approximately every 50 hours of operation, using GREASE, O.D., No. 0, and OIL, engine, seasonal grade.

156. CLEANLINESS.

a. All parts of the stabilizer must be kept clean for satisfactory operation. Moving parts which are not protected from dust should be wiped daily. The filler hole cap must be kept on the oil reservoir to prevent the entrance of dust or other foreign material.

STABILIZER SYSTEM



A — MOUNTING BOLTS
B — GEAR BOX
C — SPRING OILER
D — MULTI-PRONG PLUG
E — MOUNTING BRACKET
F — PISTON ROD END
G — PIVOT PIN
H — SPRING OILER
I — FLEXIBLE SHAFT
J — CYLINDER
K — GYRO CONTROL

RA PD 39049

Figure 143—Gyro Control, Gear Box, and Piston Rod End

157. TRUNNION FRICTION AND GUN BALANCE.

a. The performance of the stabilizer will be impaired if the amount of friction in the trunnion bearings or the unbalance of the gun exceeds a predetermined value.

b. Inspection, to determine that gun mounts are within these limits, may be made as follows:

(1) Disconnect the piston rod end (fig. 143) from the mounting bracket by removing pivot pin ($^{9}/_{16}$-in. socket and $^{9}/_{16}$-in. open-end wrenches). It will be necessary to have machine gun out while removing this pin.

(2) Install machine gun and empty shell sack and fill machine gun ammunition tray with ammunition.

(3) Install the 75-mm shell guard.

(4) Load the 75-mm gun or add weight equivalent to shell in breech.

(5) Disengage manual elevating mechanism by sliding knurled clutch release knob backward and moving elevating clutch lever to the left. It may be necessary to bear down on the shoulder guard to remove tension from the elevating pinion, due to the weight of the gun, before clutch lever can be moved.

(6) Attach a spring scale to the end of the muzzle of the gun and determine that the pull required to move the gun upward or downward does not exceed four pounds and that the difference in pull required to move gun upward and to move it downward does not exceed two pounds.

(7) Adjust balance by adding or removing laminations from counterweight. If excessive friction is encountered, notify ordnance maintenance personnel.

158. GYRO CONTROL GEAR BOX ADJUSTMENTS (figs. 143 and 144).

a. Worm Bracket End Play Adjustment.

SCREWDRIVER, 6-in.

Remove gear box end cover (6-in. screwdriver). Loosen the clamping screw (6-in. screwdriver). Adjust the end play by moving the worm bracket mounting pin down. The bracket must work freely and without appreciable end play. Tighten the clamping screw securely after making adjustments.

b. Worm End Play Adjustment.

SCREWDRIVER, 6-in. WRENCH, spanner

Remove the gear box end cover (6-in. screwdriver). Loosen the clamping screw which locks the adjusting screw in the worm bracket (6-in. screwdriver). Adjust the screw to take out end play spanner wrench). Relock in position by tightening the clamping screw.

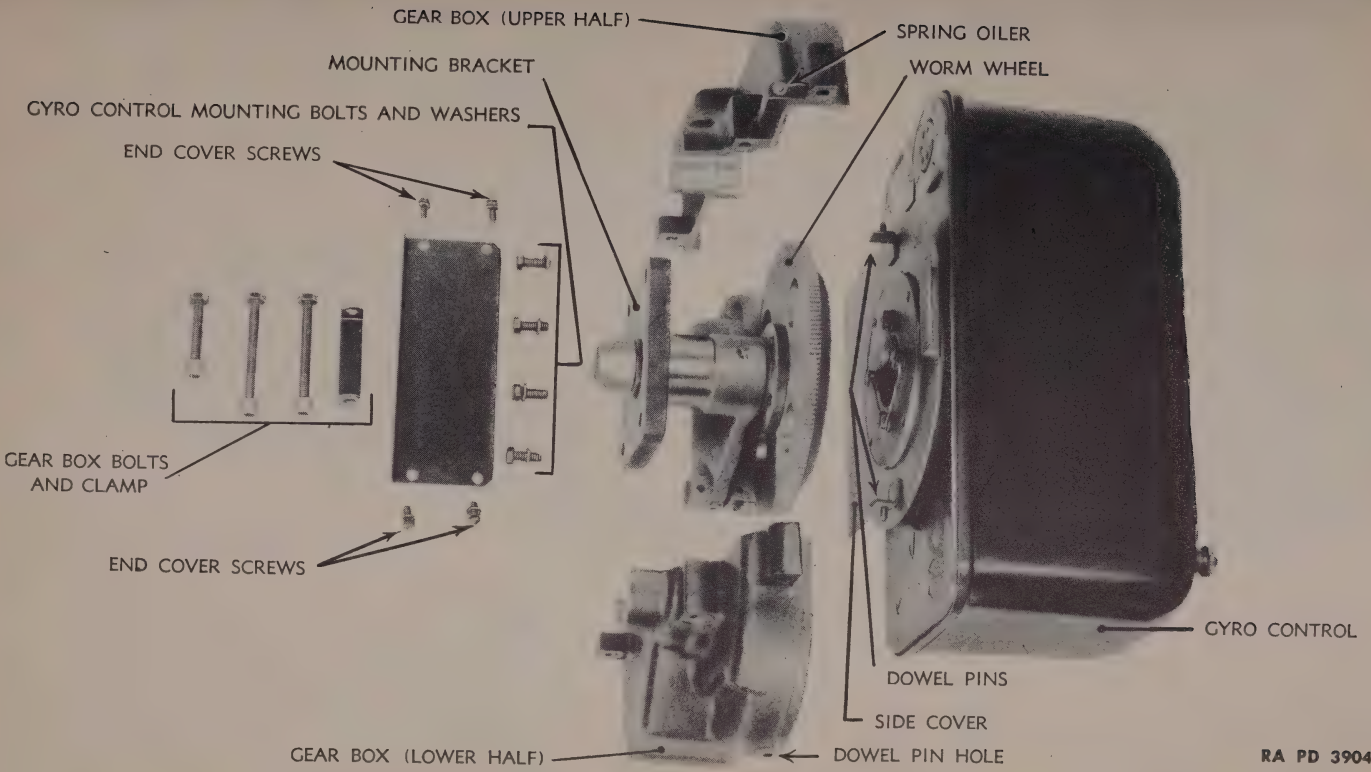


Figure 144—Gyro Control Gear Box Disassembled

159. PACKING GLANDS (figs. 145 and 146).

a. Oil Pump.

SCREWDRIVER, 4-in. WRENCH, Allen, 3/8-in.

Remove the packing access plate (4-in. screwdriver) on the Oilgear traverse or the access plug (3/8-in. Allen wrench) for the Logansport hydraulic traverse. With the pump running, turn the packing nut with a spanner wrench or screwdriver in a clockwise direction until tight. The locking spring prevents the nut from becoming loose. During installation, this adjustment is necessary several times until the packing molds itself around the shaft and provides a perfect oil seal. It should also be tightened after every 24 hours of operation.

b. Piston Rod Packing. This packing, which is chevron type, is held in place by a spring and no external adjustment is provided. Little trouble from leaks at this point should occur, as the return line relieves the oil pressure on the packing. If a leak occurs around the piston rod, the oil return line should be checked to see that it is not pinched or otherwise restricted. If the leak persists, replace the piston and cylinder (par. 164).

c. New Packing. Later models of oil pump and piston and cylinder are equipped with a self-contained oil seal. If leaks occur, this oil seal must be replaced. It is not adjustable and cannot be repaired.

160. REPLACING GYRO CONTROL.

a. The gyro control should be handled with extreme care at all times. Severe shock by dropping or jarring may injure the internal parts and cause erratic operation of the system. Under no conditions are the ordnance seals to be broken without proper authority. In the event of malfunction in the field replace the gyro control as follows:

b. Equipment.

SCREWDRIVER WRENCH, open-end, 3/8-in.
WRENCH, box, 3/8-in. WRENCH, open-end, 7/16-in.

c. Procedure.

(1) Turn stabilizer and turret switches to "OFF" position.

(2) Press release lever and remove multi-prong plug from receptacle on gyro control base (fig. 143).

(3) Remove gear box end cover (fig. 144) (6-in. screwdriver).

(4) Remove flexible shaft (6-in. screwdriver).

(5) Remove gear box clamp and two halves of gear box (3/8-in. and 7/16-in. open-end wrenches).

(6) Remove the four gyro control mounting bolts on worm wheel and remove control (3/8-in. box wrench).

(7) Install replacement unit, reverse the removal procedure.

(8) Check the operation of the complete stabilizer.

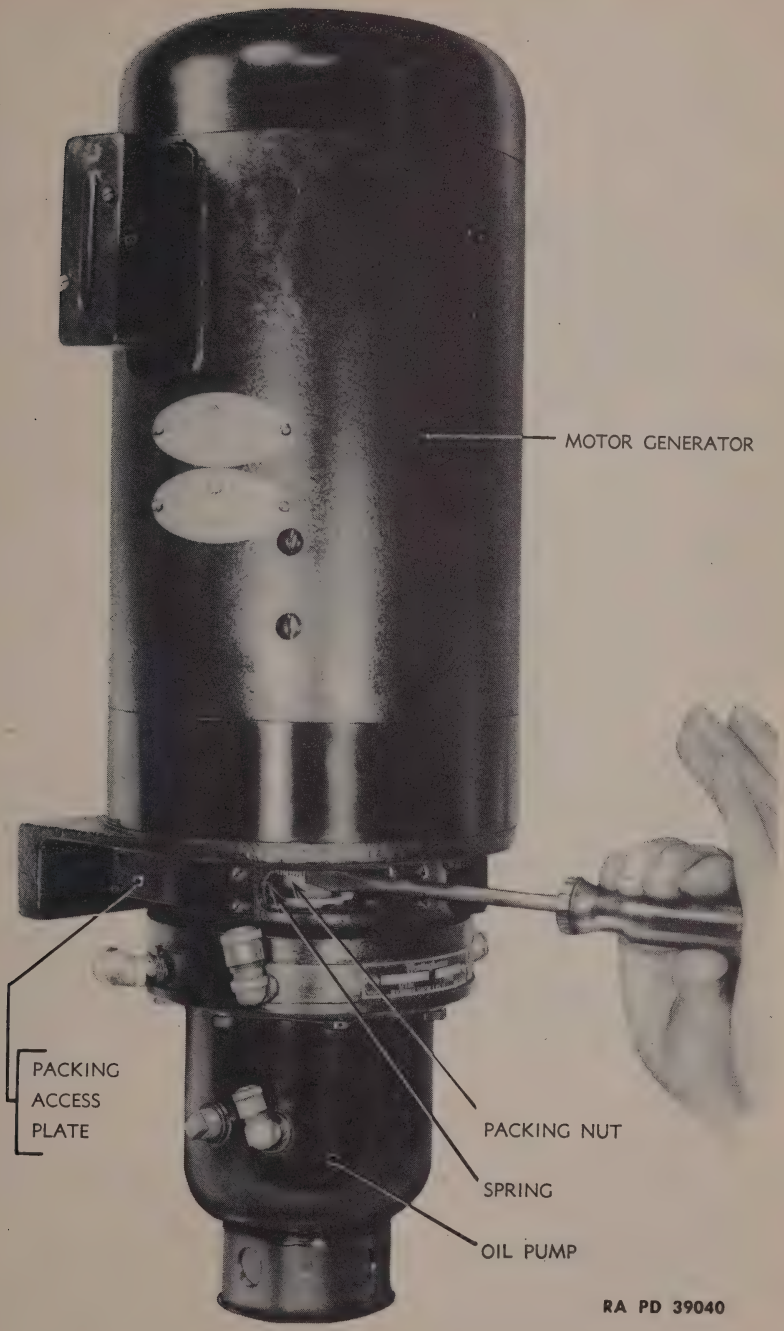


Figure 145—Packing Gland Adjustment (Installation with Electric Traverse)

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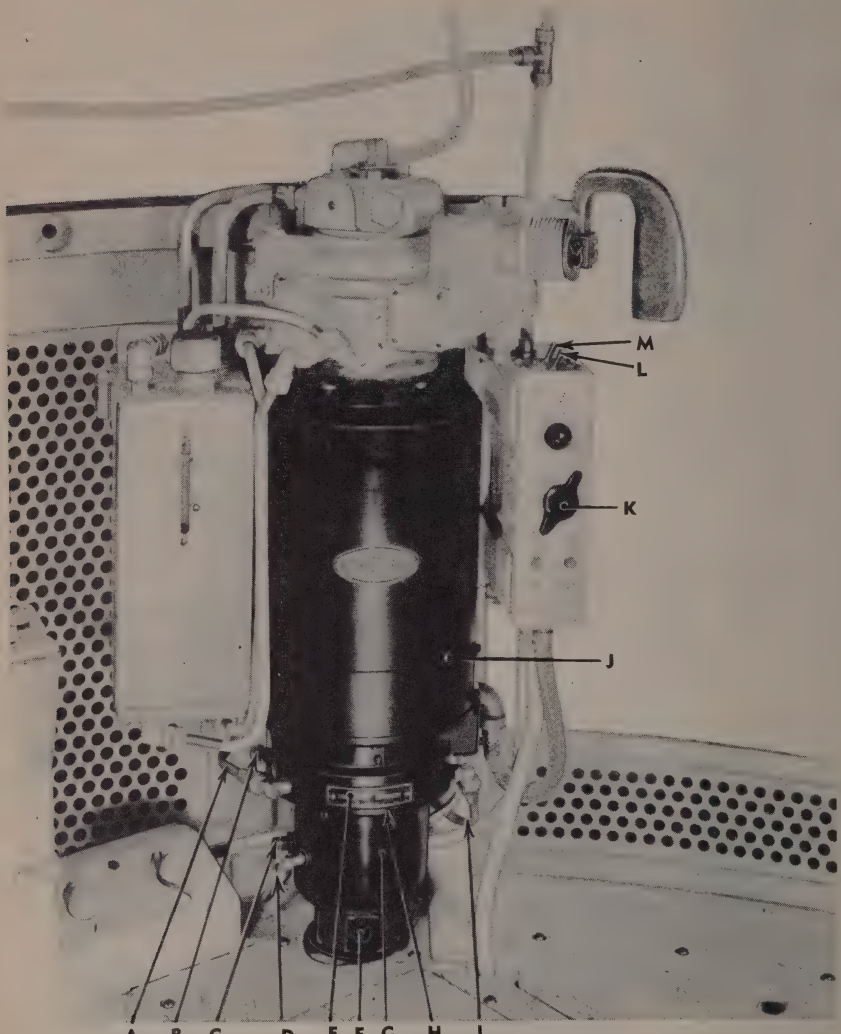


A — OIL RESERVOIR LINE
B — TOP PRESSURE LINE
C — COVER PLUG
D — OIL RETURN LINE
E — PARKING ACCESS PLATE
F — TERMINAL BOX
G — OIL PUMP
H — ALLEN BOLT
I — BOTTOM PRESSURE LINE
J — MOTOR
K — TURRET SWITCH
L — FIRING SWITCH
M — STABILIZER SWITCH

RA PD 39044

Figure 146—Stabilizer Pump and Motor (Hydraulic Traverse—Oilgear)

STABILIZER SYSTEM

161. REPLACING OIL PUMP.

a. Two types of stabilizer oil pumps are used on these medium tanks, high speed (3,600 rpm) with the Westinghouse electric traverse and standard speed (1,800 rpm) with the hydraulic traversing mechanisms supplied by the Oilgear Company and Logansport Valve Company. There are no external differences on these pumps except name plate readings. For this reason, be very careful to check the name plate before installing a replacement pump. Pumps to be used with Westinghouse electric traverse are marked "M4W," serial numbers 1 to 13,000. Those to be used with the Logansport traverse installation are marked "M4L," serial numbers 13,001 to 19,000. Those to be used with the Oilgear traverse installation are labeled "M4G," serial numbers 19,011 to 25,000. The two stabilizer oil pumps used with the two hydraulic traverse installations are interchangeable.

b. Certain early tank models lack sufficient room between the pump terminal box and the turret basket floor to remove the oil pump without taking out the motor with it. In such cases, remove the motor as described in paragraph 166, and the pump as described below, except that the pump and motor must remain connected until both have been removed from the tank. The replacement procedure for the oil pump alone is as follows:

c. Equipment.

MALLET, rawhide
SCREWDRIVER, 4-in.
WRENCH, Allen, 3/16-in.
WRENCH, box, 3/8-in.
WRENCH, box, 7/16-in.
WRENCH, open-end, 3/16-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.

d. Procedure.

(1) Turn turret and stabilizer switches to "OFF" position.

(2) Remove pump terminal box cover (4-in. screwdriver) and disconnect green, yellow, and white wires (3/8-in. box wrench) (figs. 146 and 153).

(3) Disconnect flare nut (fig. 142) on oil return line at the cylinder (3/4-in. open-end wrench).

(4) Open bleeders on cylinder to provide an air vent (5/16-in. and 3/8-in. open-end wrenches).

(5) Remove filler plug from oil reservoir (7/16-in. box wrench).

(6) Make some provision to catch oil, remove plug from pump cover (3/8-in. box wrench) and allow oil to drain out.

(7) Disconnect four oil lines at pump elbows (3/4-in. and 7/8-in. open-end wrenches).

(8) Cap oil connections on pump with flare nuts and dead heads.

(9) Remove bolts in pump cover rim ($\frac{7}{16}$-in. open-end or $\frac{3}{16}$-in. Allen wrench).

(10) While pulling pump out of mesh with drive motor, tap pump base plate with rawhide mallet. CAUTION: The pump cover must never be removed except by authorized persons.

(11) To install replacement unit, reverse the removal procedure, observing the following precautions:

(a) Be sure the pump and motor shaft mesh properly.

(b) Be sure wiring is correct. Check with wiring diagram (fig. 153).

(c) Recharge the system with oil and check for air in the system.

(d) Check the operation of the complete stabilizer.

162. REPLACING CONTROL BOX.

a. Equipment.

COPPER, soldering
SCREWDRIVER, 4-in.
WRENCH, open-end, $1\frac{1}{32}$-in.
WRENCH, open-end, $\frac{7}{16}$-in. (2)

b. Procedure.

(1) Throw the turret and stabilizer switches to the "OFF" position.

(2) Remove top cover (4-in. screwdriver) and disconnect wiring (soldering copper or $1\frac{1}{32}$-in. open-end wrench).

(3) Remove mounting screws (two $\frac{7}{16}$-in. open-end wrenches) and remove control box.

(4) To install replacement unit, reverse the removal procedure. Be sure to reconnect the wires according to the wiring diagram (fig. 153).

(5) Check the operation of the complete stabilizer.

163. REPLACING DISENGAGING SWITCH (fig. 147).

a. Equipment.

FILE, round
SCREWDRIVER, 4-in.
SCREWDRIVER, 6-in.
WRENCH, open-end, $\frac{5}{16}$-in.

b. Procedure.

(1) Throw the turret and stabilizer switches to the "OFF" position.

(2) Remove switch mounting screws (6-in. screwdriver) and switch from hand-elevating mechanism.

(3) Remove switch cover plate ($\frac{5}{16}$-in. open-end wrench) and disconnect wiring (4-in. screwdriver).

(4) Unscrew switch from shielded conduit fitting (pliers).

(5) To install replacement switch, reverse the removal procedure.

(6) The disengaging switch is closed normally. The switch plunger must not protrude more than $\frac{1}{16}$-inch when the clutch lever is thrown to the left and the elevating gears are in mesh. Adjust by shifting the switch. If the switch mounting holes are not oversize, enlarge as necessary with round file.

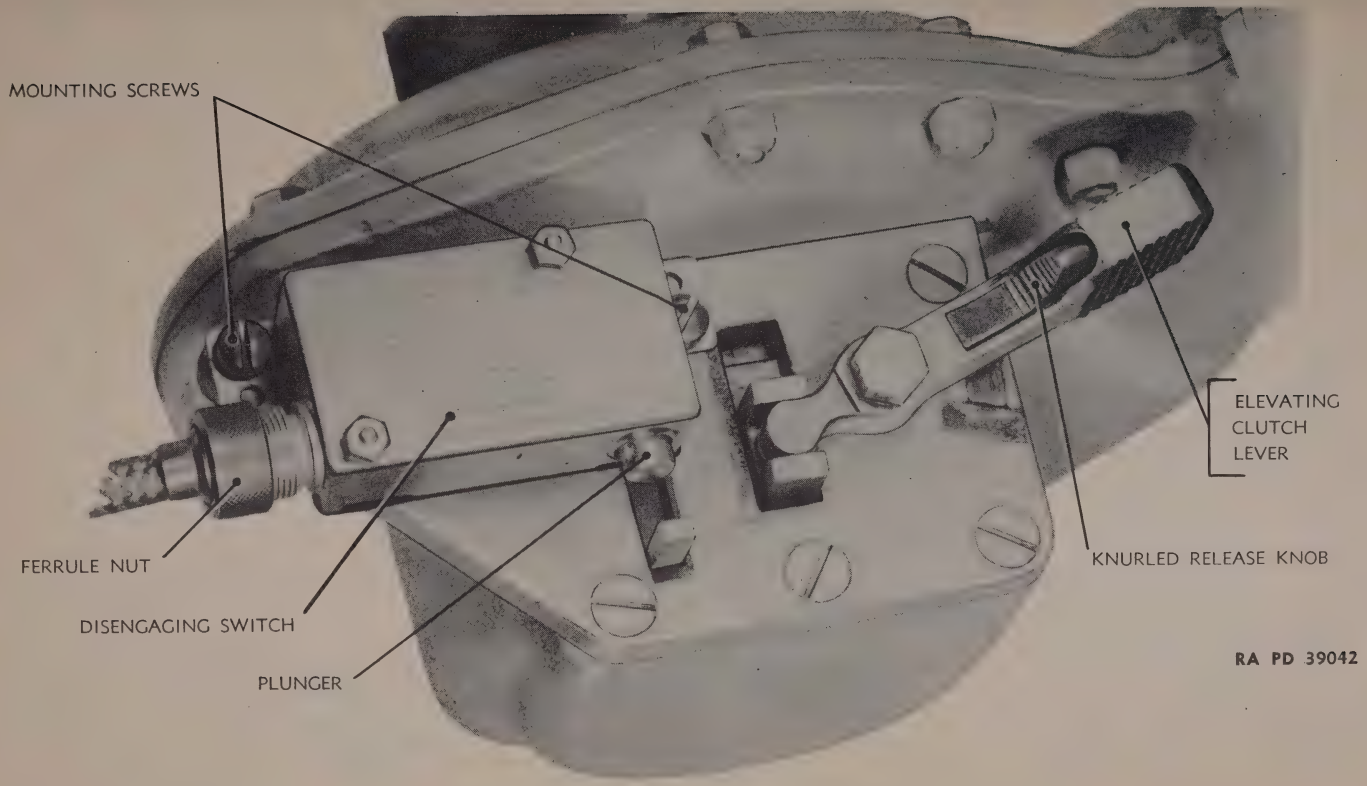


Figure 147—Disengaging Switch and Elevating Clutch Lever

164. REPLACING PISTON AND CYLINDER (fig. 141).

a. If parts become damaged, bearings or pivot pins worn, or leaks occur around the piston rod, replace the unit as follows:

b. **Equipment.**

CAN, oil
SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.

c. **Procedure.**

(1) Turn turret and stabilizer switches to "OFF" position.

(2) Disconnect and plug the three oil line connections (3/4-in. and 7/8-in. open-end wrenches). Make provisions to catch oil lost when disconnecting lines.

(3) Remove the four pivot pin clamp bolts (9/16-in. open-end wrench and 9/16-in. socket wrench).

(4) Remove two bottom bolts on rod end mounting bracket and loosen top bolt (3/4-in. socket wrench). Tilt bracket so pivot pin will clear machine gun mounting bracket.

(5) Spring piston rod end mounting bracket with screwdriver and slide out pivot pin.

(6) Spring cylinder mounting bracket, remove pivot pin, and take out piston and cylinder.

(7) To install replacement unit, reverse the removal procedure, recharge the system with oil and remove air.

(8) Check the operation of the complete stabilizer.

165. REPLACING RECOIL SWITCH (fig. 148).

a. **Equipment.**

FILE, round
PLIERS
SCREWDRIVER, 4-in.
WRENCH, open-end, 5/16-in.
WRENCH, open-end, 7/16-in. (2)

b. **Procedure.**

(1) Throw the turret and stabilizer switches to the "OFF" position.

(2) Remove the two mounting bolts (two 7/16-in. open-end wrenches) and switch bracket.

(3) Remove switch cover plate (5/16-in. open-end wrench) and disconnect wiring (4-in. screwdriver).

(4) Unscrew switch from shielded conduit fitting (pliers).

(5) To install replacement switch, reverse the removal procedure.

(6) The recoil switch is normally closed and mounted so its plunger will be depressed by the breech of the gun. The plunger must not protrude more than 1/16-inch when the gun is in battery position. Adjust

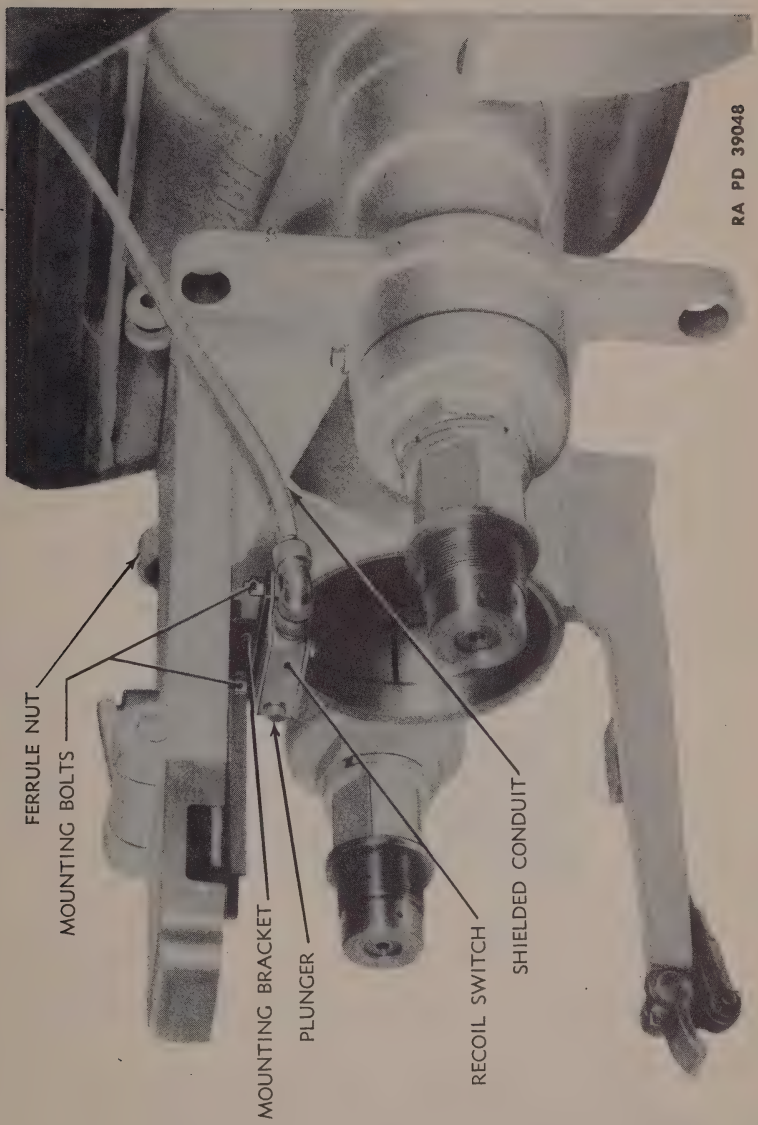


Figure 148—Recoil Switch

by shifting the switch mounting bracket or the switch. If the switch mounting holes are not oversize, enlarge as necessary with round file.

166. REPLACING PUMP MOTORS.

a. Three types of motors are used on the stabilizer oil pump of these tanks. Each of these motors supplies power for both the stabilizer and the traverse.

(1) The Westinghouse motor generator with the electric traverse (fig. 149).

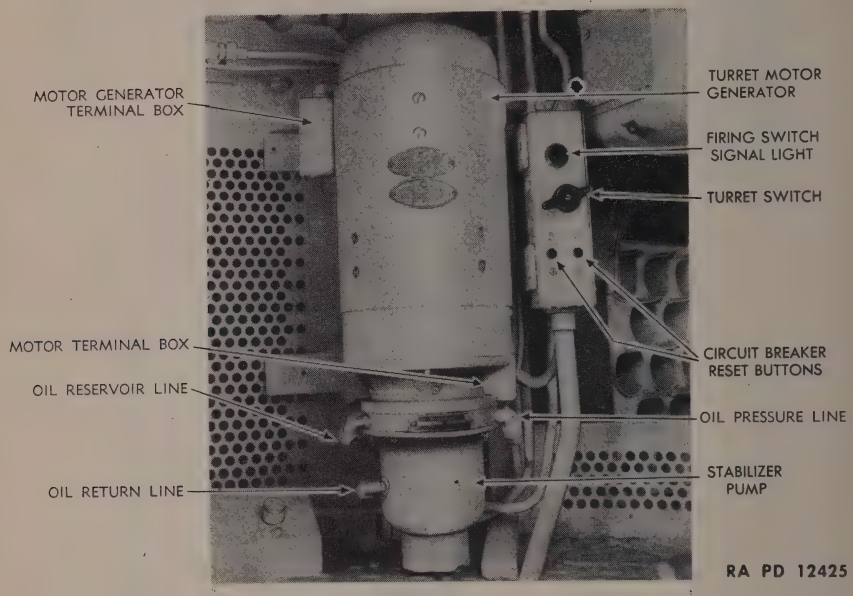


Figure 149—Westinghouse Motor Generator

(2) The Westinghouse motor with Oilgear hydraulic traverse (fig. 146).

(3) The Pioneer Pincor motor with Logansport hydraulic traverse.

b. Replacing Westinghouse Motor-Generator (fig. 149).

COPPER, soldering
SCREWDRIVER, 6-in.
WRENCH, Allen, $^{3}/_{16}$-in.
WRENCH, open-end, $^{7}/_{16}$-in.
WRENCH, open-end, $^{15}/_{16}$-in.
WRENCH, socket, $^{3}/_{4}$-in. with 8-in. and 4-in. extension (2)

(1) Throw the turret switch to the "OFF" position.

(2) Remove mounting bolts from pump at cover rim and remove pump ($^{7}/_{16}$-in. open-end or $^{3}/_{16}$-in. Allen wrench).

(3) Suspend pump to prevent damage to copper tubing.

(4) Disconnect wires at generator terminal box (6-in. screwdriver and soldering copper).

(5) Disconnect the 24-volt supply line at motor terminal box (6-in. screwdriver and $^{15}/_{16}$-in. open-end wrench).

(6) Support motor with hands and remove the four mounting bolts, a two-man operation (two $^{3}/_{4}$-in. socket wrench with 8-in. and 4-in. extensions).

(7) Lift out motor-generator, also a two-man operation.

(8) To install replacement unit, reverse the removal procedure. Check wiring with wiring diagram (fig. 153).

(9) Check the operation of the complete stabilizer and traverse.

c. Replacing Westinghouse Motor with Oilgear Traverse (fig. 146).

SCREWDRIVER, 6-in.
WRENCH, open-end, $^{7}/_{16}$-in. or
WRENCH, Allen, $^{3}/_{16}$-in.
WRENCH, open-end, $^{15}/_{16}$-in.
WRENCH, socket, $^{3}/_{4}$-in. (2), with 8-in. and 4-in. extensions

(1) Turn turret switch to the "OFF" position.

(2) Remove mounting bolts from the cover of the oil pump and move pump out sufficiently to disengage drive shaft from motor ($^{7}/_{16}$-in. open-end wrench or $^{3}/_{16}$-in. Allen wrench).

(3) Suspend pump in its original position, being careful not to damage the flare connections or copper tubing.

(4) Remove traverse hydraulic pump from opposite end of motor. Suspend it in position to prevent damage to the oil lines.

(5) Disconnect the 24-volt supply line to motor (6-in. screwdriver and $^{15}/_{16}$-in. open-end wrench).

(6) Remove four mounting bolts from mounting brackets of motor and remove motor (two $^{3}/_{4}$-inch socket wrenches with 8-inch and 4-inch extensions).

(7) To install replacement motor, reverse the removal procedure.

(8) Check operation of the complete stabilizer.

167. REPLACING GEAR BOX (fig. 143).

a. Adjustments for the gear box are given in paragraph 158. If parts are damaged or worn, replace the entire unit as follows:

b. Equipment.

SCREWDRIVER
WRENCH, box, $^{3}/_{8}$-in.
WRENCH, box, $^{1}/_{2}$-in.
WRENCH, open-end, $^{3}/_{8}$-in.
WRENCH, open-end, $^{7}/_{16}$-in.

c. Procedure.

(1) Turn turret switch to "OFF" position.

(2) Press release lever and remove multi-prong plug from gyro control base (fig. 143).

(3) Remove gear box end cover (6-in. screwdriver) (fig. 144).

(4) Loosen flexible shaft clamping screw (6-in. screwdriver and remove flexible shaft).

(5) Remove mounting bolts holding gear box to mounting bracket (two ½-in. box wrenches) and remove gear box and gyro control as a unit (fig. 143).

(6) Remove gear box bolts and clamp and two halves of gear box (⅜-in. and 7/16-in. open-end wrench).

(7) Remove the four gyro control mounting bolts from the worm wheel and remove gyro control (⅜-in. box wrench).

(8) To install replacement unit, reverse the removal procedure.

(9) Adjust worm and worm bracket.

(10) Check the operation of the complete stabilizer.

168. REPLACING WIRING AND SHIELDED CONDUIT.

a. Equipment.

COPPER, soldering or torch
PLIERS
TAPE, friction
TAPE, rubber
SOLDER, 50-50

b. Procedure.

(1) Turn turret switch to "OFF" position.

(2) Measure new piece of shielded conduit to length and tin at least ½-inch on each side of cut using noncorrosive flux (torch or soldering copper).

(3) Cut with fine-toothed hacksaw.

(4) Tin inside of ferrule (solder 50-50, and soldering copper).

(5) Sweat solder cable into place. *If a torch is used, use flame on fitting only, never directly on cable.*

(6) Cut new wires to length and run them through shielded cable.

(7) When rewiring, follow the color scheme and connections shown in the wiring diagram (fig. 153).

(8) Reconnect wires and shielded conduit (soldering copper, friction tape, rubber tape and pliers).

169. REPLACING CLUTCH PARTS (fig. 150).

a. The clutch is not adjustable. To replace:

b. Equipment.

HAMMER
PLIERS
PUNCH, center
WRENCH, open-end, ⅜-in.

c. Procedure.

(1) Turn the turret switch to the "OFF" position.

Figure 150—Gyro Control Clutch Parts

MEDIUM TANKS M4 AND M4A1

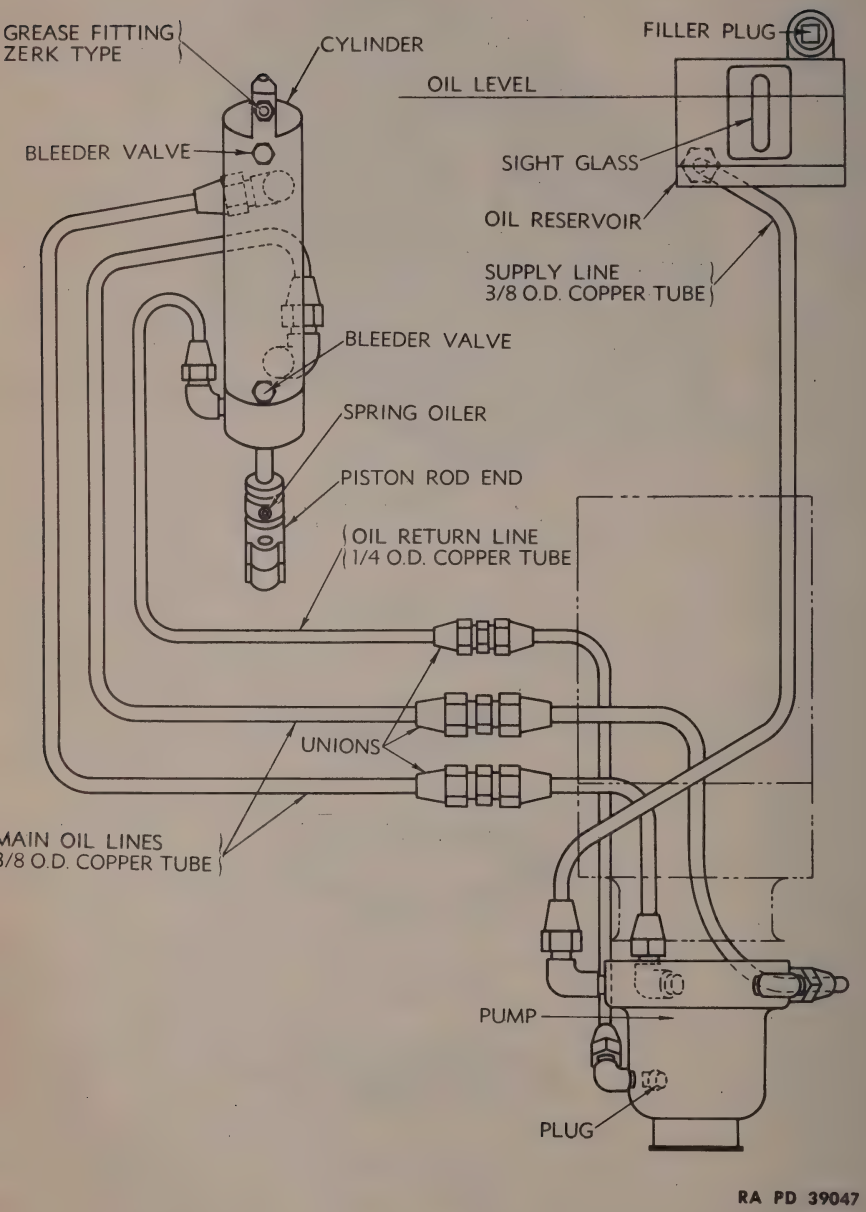


Figure 151—Stabilizer Piping Diagram

(2) Remove the gyro control (par. 160).

(3) Remove locking wire (pliers) from mounting plate bolts and remove mounting bolts (3/8-in. open-end wrench) and plate.

(4) Remove mounting screws (6-in., screwdriver) from retainer plate and remove retainer plate.

(5) Remove clutch plate and clutch springs.

(6) Replace retainer plate, clutch plate, and two clutch springs. Add one spring if only one is present.

(7) To install, reverse the removal procedure. Stake the mounting screws on retainer plate (hammer and center punch).

(8) Retest clutch, and check the operation of the complete stabilizer.

170. REPLACING FLEXIBLE SHAFT.

a. Equipment.

SCREWDRIVER, 6-in.
WRENCH, open-end, 1½-in.

b. Procedure.

(1) Remove end cover from the gear box (6-in. screwdriver).

(2) Loosen the flexible shaft clamping screw (6-in. screwdriver).

(3) Pull shaft out through felt packing.

(4) At opposite end of shaft, unscrew flange nut (1½-in. open-end wrench) and remove flexible shaft from hand elevating mechanism.

(5) To install replacement shaft, reverse the removal procedure.

171. REPAIRING AND REPLACING DEFECTIVE OIL LINES.

a. Equipment.

CUTTER, tube
TOOL, flaring
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.

b. Procedure.

(1) Turn turret switch to "OFF" position.

(2) Disconnect the defective oil line (3/4-in. or 7/8-in. open-end wrench) and catch oil drainage from the affected part of the system. Replace damaged lines completely (fig. 151).

(3) Use extreme care to keep dirt or other foreign material out of the hydraulic system. For this reason, when making a flare, cut the tubing with a tube cutter instead of a hacksaw. Feed the cutting wheel (fig. 152) a very small amount each time the tool is rotated 360 degrees until the tube is cut. If the cutter is fed too rapidly, the end of the tubing may be beveled inward. Slip the flare nut over the end of the tube and grip the tube in the flaring tool block, allowing the end to project approximately 1/16-inch. Do not turn it down too hard as the flared end will be thinned out and become brittle. The flared end of the tube should be sufficiently large to form a good seat on the male part of the flare

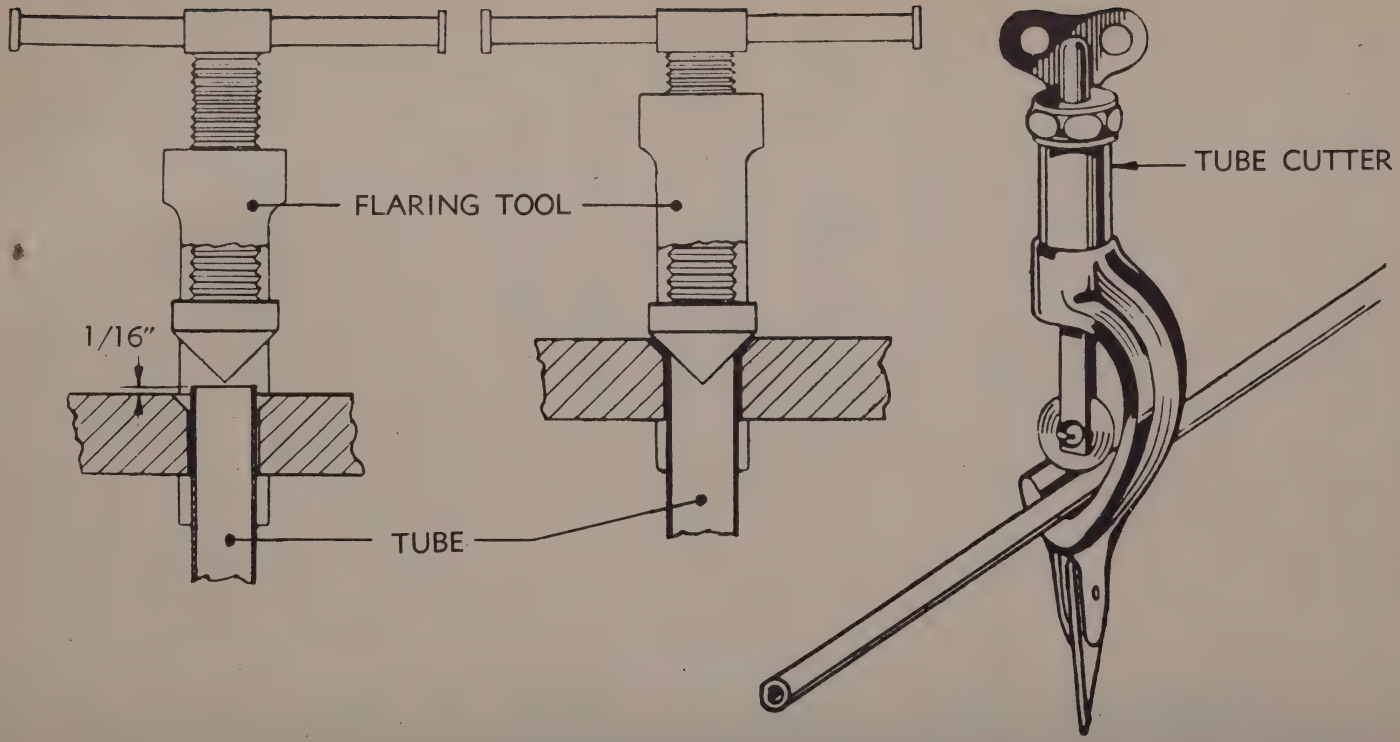


Figure 152—Flaring Tools

connection, yet it must not be so large that it will not clear the threads of the flare nut. When making the connections, draw the flare nuts up tightly, but if they are forced too tightly the flare may be thinned out and consequently weakened.

(4) Reconnect the flare nut to its proper connection.

(5) Recharge the system with oil and check for air in the system.

(6) Check the operation of the complete stabilizer.

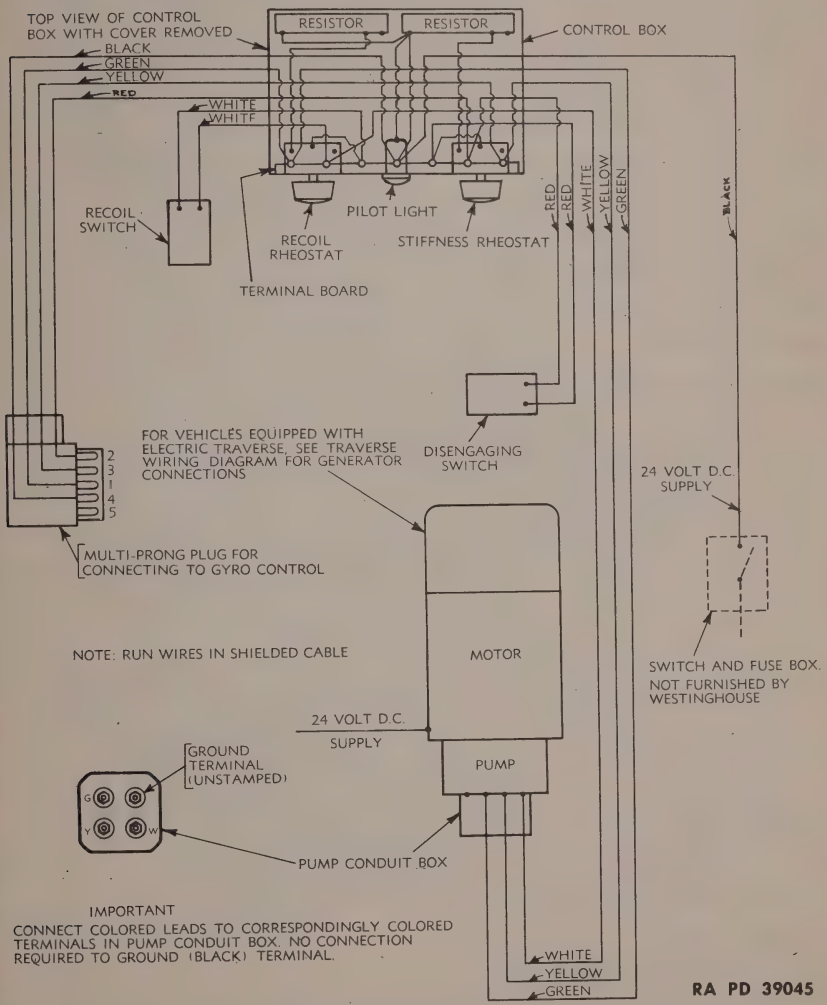


Figure 153—Electrical Wiring Diagram for Stabilizer

Section XXV

ELECTRICAL TURRET TRAVERSING SYSTEM

	Paragraph
Checking traverse operation	172
Testing, removal and installation of motor generator	173
Replacing motor generator and drive motor brushes	174
Removal and installation of drive motor or gear box	175
Removal and installation of silverstat control	176
Removal and installation of handwheel	177
Removal and installation of front cover, oil seal, handwheel hub, idler gear, or lock lever	178
Removal and installation of flange and gear assembly	179
Replacing commander's switch	180
Replacing gunner's switch	181
Replacing wiring	182
Replacing disengaging switch	183

172. CHECKING TRAVERSE OPERATION (fig. 154).

a. Before operating the electric traverse in combat and at each 250-mile inspection, the following tests and inspections should be made with the tank standing still. In event of unsatisfactory operation after servicing, replace components as described in paragraphs 173 to 183. Check the equipment as follows:

b. Equipment.

BAR, square, 3/8-in.
CHALK or PAINT
CLOTH, clean
GAGE, feeler
GREASE, general purpose, No. O, and No. 1
OIL, engine, seasonal grade
RULE, 6-in.
SCREWDRIVER, 8-in.
STRAIGHTEDGE, 12-in.
WATCH (with second hand)
WRENCH, box, 3/8-in.
WRENCH, socket, 3/4-in., with 8-in. extension.

c. Procedure.

(1) *Check the mesh between the traverse drive gear and the turret ring gear while making one complete revolution of the turret with the handwheel in manual operation.*

GAGE, feeler
WRENCH, socket, 3/4-in, with 8-in. extension

Minimum clearance between traverse drive gear and turret ring gear

ELECTRICAL TURRET TRAVERSING SYSTEM

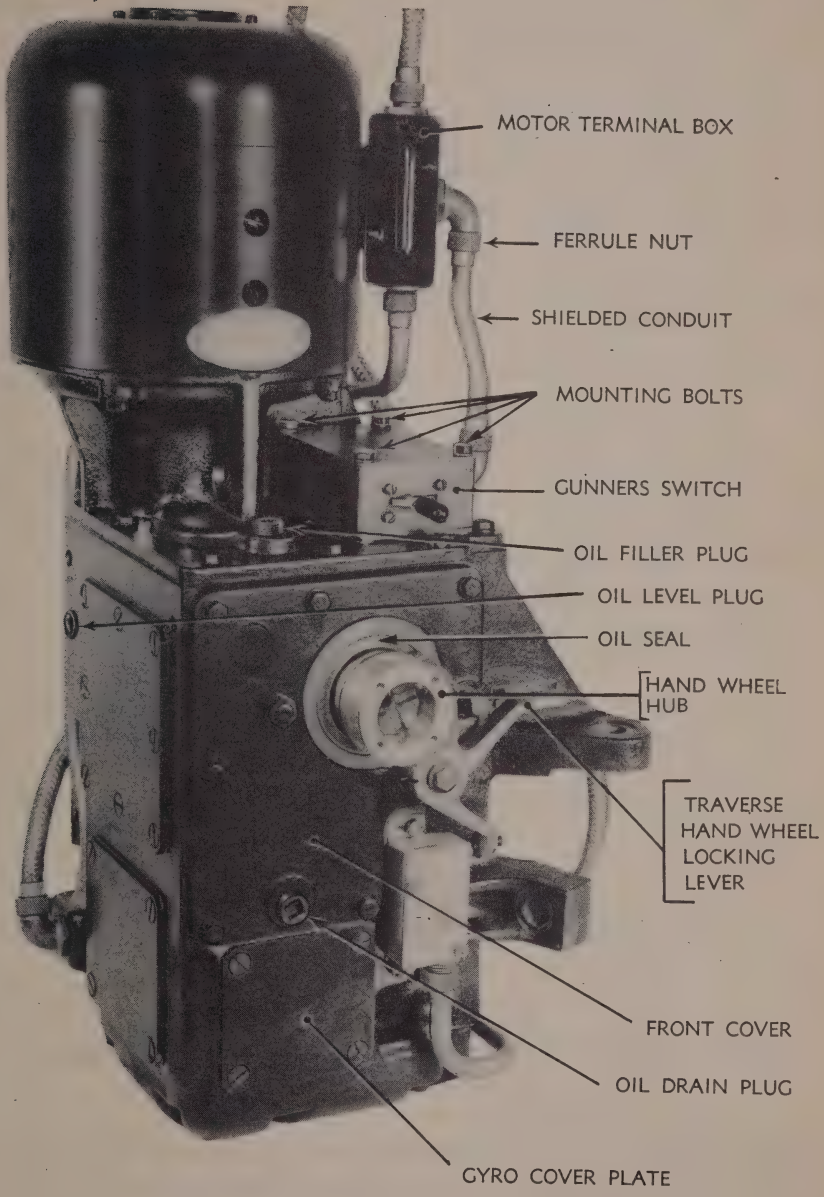
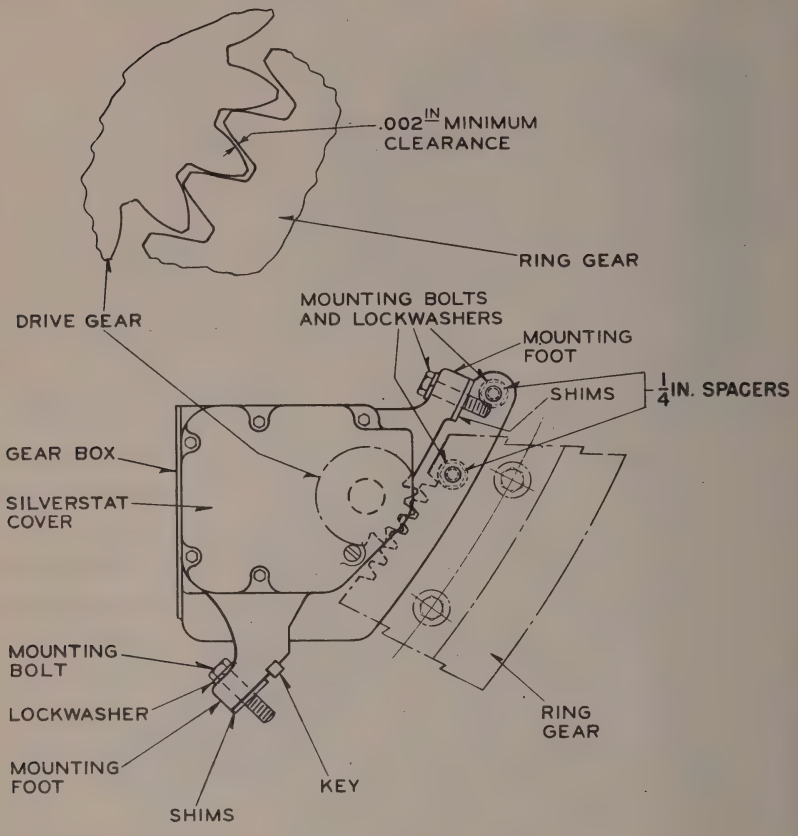


Figure 154—Drive Motor and Gear Box



BOTTOM VIEW OF GEAR BOX SHOWING MOUNTING AND MESH BETWEEN DRIVE GEAR AND RING GEAR.

RA PD 51183

Figure 155—Mesh Between Traverse Drive Gear and Turret Ring Gear

is 0.002 inch at the tightest point (fig. 155). Rotate the turret showing a complete revolution in manual operation. Stop frequently to locate the point of minimum clearance. There must be no binding at minimum clearance and satisfactory mesh at maximum clearance. To adjust clearance between gears: Remove horizontal mounting bolts and loosen vertical mounting bolts (¾-in. socket wrench with 8-in. extension). Correct shims on horizontal mounting bolts as necessary. Shim equally under each bolt, if possible. Reinstall and tighten mounting bolts.

ELECTRICAL TURRET TRAVERSING SYSTEM

(2) CHECK ANGULAR LAG BETWEEN THE HANDWHEEL AND THE TURRET RING GEAR.

RULE, 6-in. STRAIGHTEDGE, 12-in.

Maximum lag of the handwheel in power and in manual operation is three inches measured at the diameter of the handwheel. Turn handwheel in power position in one direction a quarter turn. Place straightedge over handwheel and parallel to gunner's switch. Mark handwheel along straightedge. Turn handwheel slowly in opposite direction until turret ring gear just begins to move. Replace straightedge in same position along gunner's switch and again mark handwheel along straightedge. Measure distance from first to second mark to determine lag. Repeat this procedure for opposite rotation of handwheel and for rotation of handwheel in both directions in power operation. If 3 inch limit is exceeded, replace the gear box.

(3) CHECK TURRET SPEED.

WATCH (with second hand)

With tank on level ground operate turret with gunner's or commander's switch. Minimum speed is 4 revolutions per minute or 1 revolution in 15 seconds. If equipment fails to operate or does not operate at proper speed notify ordnance maintenance personnel. Check speed in both directions with both gunner's and commander's switches.

(4) CHECK LUBRICATION OF RING GEAR.

GREASE, general purpose No. 1, above 32F, and No. 0, below 32F

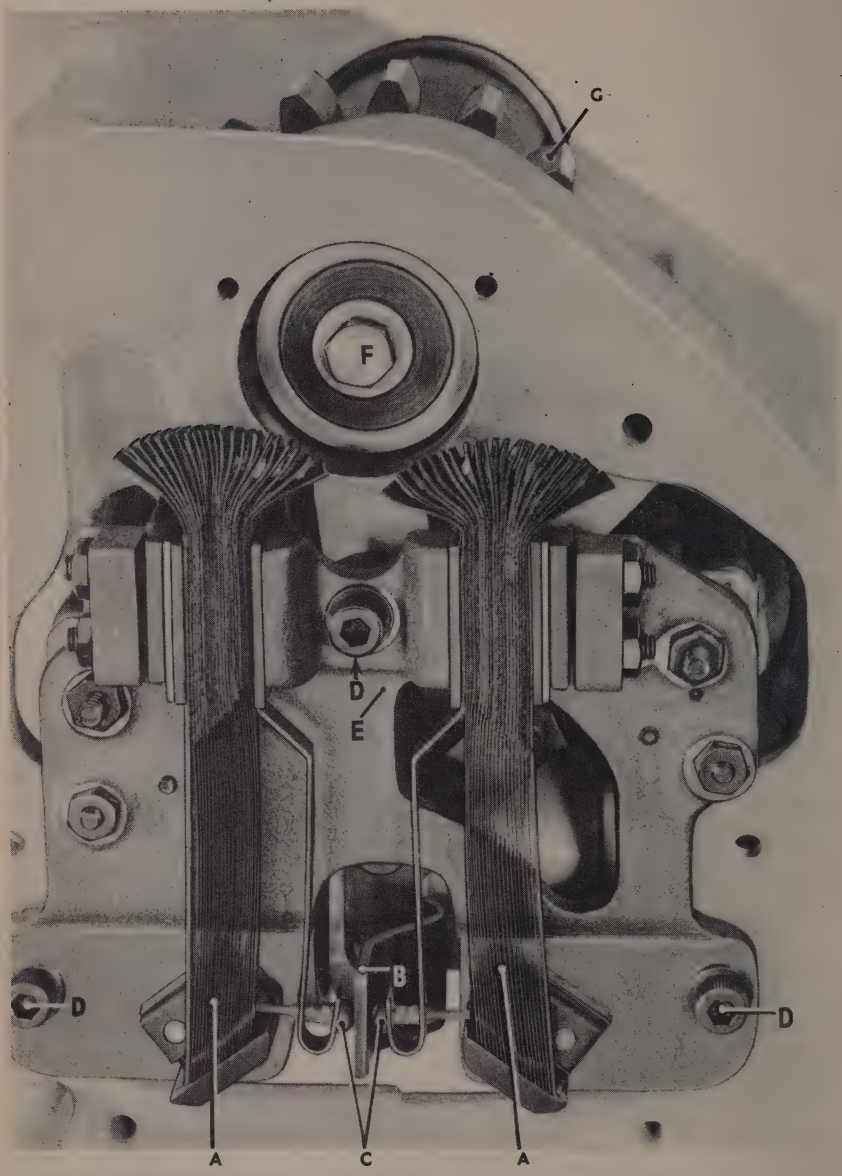
Grease should be adequate but not dripping. If necessary, add GREASE, general purpose No. 1, above 32F, and No. 0, below 32F while turning the turret one complete revolution. Three grease fittings are located around the ring gear.

(5) CHECK VEHICLE BATTERY VOLTAGE WHICH MUST BE BETWEEN 24 AND 28 VOLTS. If voltage is low, recharge with Homelite auxiliary generator as necessary. If voltage is too high, voltage regulators need to be adjusted, notify ordnance maintenance personnel.

(6) CHECK CLUTCH (fig. 156).

CHALK or PAINT SCREWDRIVER

Traverse the turret 45 degrees in either direction with gunner's or commander's switch. A gliding movement after the switch is released indicates a loose clutch. Rapid vibration of the turret when switch is released indicates a tight clutch. Adjust, if necessary, as follows. Remove six mounting screws (screwdriver) and cover plate from the bottom of the motor gear box. Remove clutch cover plate (screwdriver). If clutch is too loose, tighten elastic stop adjusting nut (fig. 156) one-eighth turn and recheck operation. Repeat until satisfactory operation is obtained.



A — SILVERSTATS
B — SPACER
C — INSULATED BUTTONS
D — ALLEN MOUNTING BOLTS
E — SILVERSTAT CRADLE
F — CLUTCH ADJUSTING NUT
G — DRIVE GEAR

RA PD 39058

Figure 156—Silverstat and Clutch Assembly

ELECTRICAL TURRET TRAVERSING SYSTEM

Clutch adjustments are critical and should be made very carefully. If clutch is too tight, loosen adjusting nut one-eighth turn and check. Repeat this operation until satisfactory operation is obtained. Reinstall clutch cover plate and bottom cover plate. Normal clutch slippage is from one to two teeth on the turret drive gear. This slippage may be accurately measured by marking clutch housing and turret drive gear and observing displacement after operating turret in both directions as described above.

(7) CHECK DISENGAGING SWITCH (fig. 157).
RULE, 6-in.

In manual operation the plunger should protrude no more than 1/16-inch. In electrical operation, the plunger should be as far out as it will go and the lock lever disengaging arm adjusting screw should not touch it. The lock lever stop must be adjusted so the locking arm will clear the handwheel hub when changing from one type of operation to another. Set the lock lever stop first, then set the locking arm adjusting screw.

(8) CHECK FOR OIL LEAKS ON GEAR BOX (fig. 157).
SCREWDRIVER, 8-in.

Visually inspect oil seal around hub, which is self-lubricating. If oil drips, replace oil seal (par. 178). Check the front cover and side cover gaskets on the gear box. Tighten screws or replace gaskets, if necessary (8-in. screwdriver). Remove front gyro cover and check for oil leaks around tapered shaft bearing and washer (8-in. screwdriver). If leaks are found, replace oil seals. The motor-gear box must be removed from the vehicle and partially disassembled to replace oil seals (par. 178).

(9) CHECK OIL LEVEL IN GEAR BOX (fig. 157).
BAR, square, 3/8-in. WRENCH, box, 3/8-in.
OIL, engine, seasonal grade

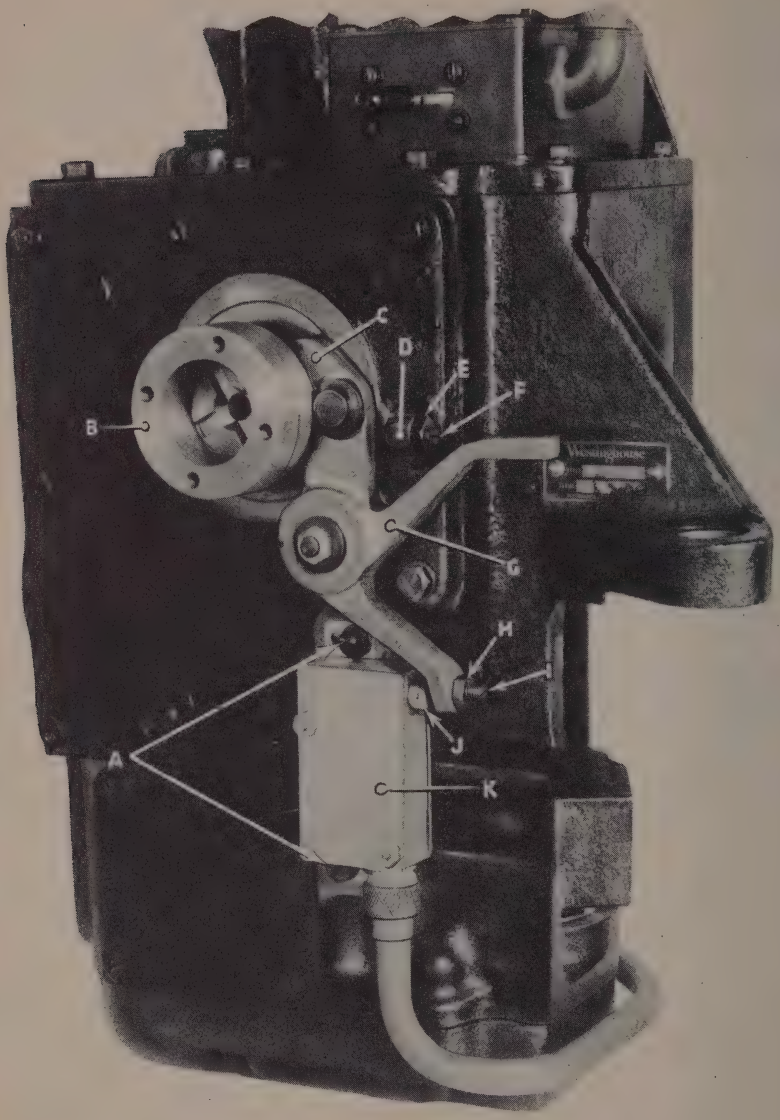
Remove oil level plug (3/8-in. square bar and 3/8-in. box wrench). Keep oil up to the level of this plug. To fill, remove filler plug and add oil as necessary, OIL, engine, seasonal grade. Replace filler and oil level plugs.

(10) CHECK CLEANLINESS.
CLOTH, clean

Remove all excess grease on turret ring gear. Clean dirt and grease from all exposed parts. Moving parts not protected from dust should be wiped daily.

(11) CHECK MOUNTING BOLTS.
WRENCH, socket, 3/4-in., with 8-in. extension

Check for tightness of mounting bolts of motor generator and traverse motor gear box and be sure they are kept tight.



A — MOUNTING SCREWS
B — HAND WHEEL HUB
C — LOCK LEVER FLANGE
D — LOCK LEVER STOP
E — LOCK NUT
F — ADJUSTING SCREW
G — LOCK LEVER
H — LOCK NUT
I — ADJUSTING SCREW
J — PLUNGER
K — DISENGAGING SWITCH

RA PD 39053

Figure 157—Front of Gear Case—Handwheel Removed

ELECTRICAL TURRET TRAVERSING SYSTEM

173. TESTING, REMOVAL AND INSTALLATION OF MOTOR GENERATOR (figs. 27 and 158).

a. Testing. If all other checks have failed to locate the cause of faulty operation, check the motor generator as follows:

(1) Turn the turret switch off.

(2) Unsolder the wires A1 and A2 (fig. 167 or 168) in generator terminal box from the terminals with soldering copper.

(3) Check voltage output with voltmeter. Readings must be between 220 and 250 volts at full speed.

(4) If motor does not run or if voltage is not within the above limits, the unit must be replaced.

b. Removal from Vehicle.

COPPER, soldering
SCREWDRIVER, 6-in.
WRENCH, Allen, 3/16-in.
WRENCH, box, 7/16-in.
WRENCH, open-end, 15/16-in.
WRENCH, socket, 3/4-in. (2), with 8-in. and 4-in. extensions

Turn turret switch "OFF". Remove generator terminal box cover (6-in. screwdriver). Disconnect leads in generator terminal box (soldering copper). Remove motor terminal box cover (6-in. screwdriver). Disconnect 24-volt supply line (15/16-in. open-end wrench). Remove four screws (3/16-in. Allen or 7/16-in. box wrench) holding stabilizer pump to motor. Do not disconnect stabilizer oil lines. Tie pump to side of basket to prevent damage to the oil lines. Hold motor-generator in place and remove four mounting bolts (two 3/4-in. socket wrenches) with 8-in. and 4-in. extensions . This is a two-man operation. Lift motor-generator out of vehicle; also a two-man operation.

c. Installation in the Vehicle.

COPPER, soldering
SCREWDRIVER, 6-in.
TAPE, friction
TAPE, rubber
WRENCH, Allen, 3/16-in.
WRENCH, box, 7/16-in.
WRENCH, open-end, 15/16-in.
WRENCH, socket, 3/4-in. with 4-in. extension
WRENCH, socket, 3/4-in. with 8-in. extension

Place and hold the motor-generator in position on the turret wall with the generator on top. This is a two-man operation. Insert and tighten the four mounting bolts (two 3/4-in. socket wrenches, with 8-in. extension and with 4-in. extension). Connect the 24-volt supply line in motor terminal box (15/16-in. open-end wrench). Connect all wires in generator terminal box according to the wiring diagram with soldering copper (figs. 167 or 168). Tape ends securely, first with rubber tape, then with friction tape. Replace terminal box covers (6-in. screwdriver). Install stabilizer oil pump with four screws (3/16-in. Allen or 3/16-in. box wrench). Check the operation of the complete traverse (par. 172).

MEDIUM TANKS M4 AND M4A1

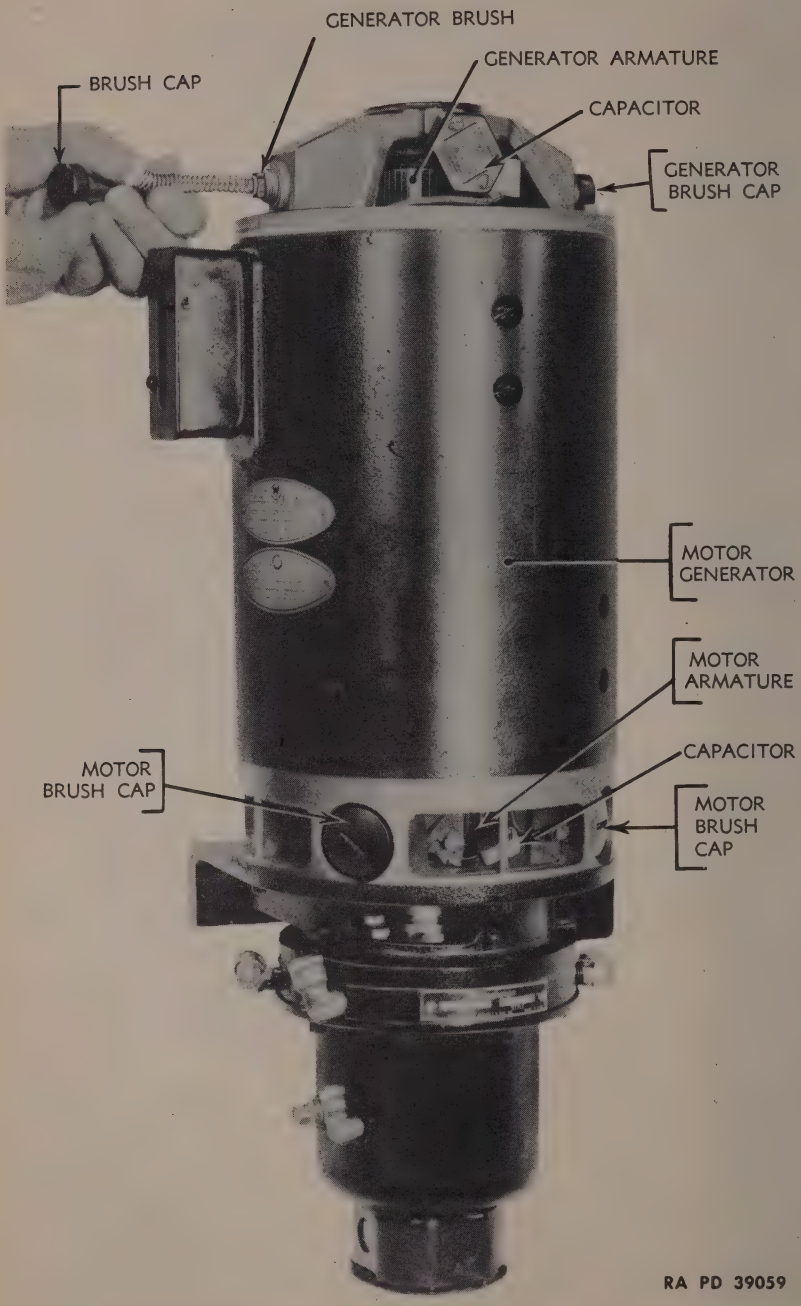


Figure 158—Motor Generator and Stabilizer Oil Pump

ELECTRICAL TURRET TRAVERSING SYSTEM

174. REPLACING MOTOR GENERATOR AND DRIVE MOTOR BRUSHES (figs. 158 and 159).

CLOTH, clean
PAPER, flint, No. 00
SCREWDRIVER, 8-in.

Turn turret and traverse switch to the "OFF" position. Check motor generator commutators for nicks, scores, and scratches. Clean generator armature with paper, flint, No. 00, and a clean cloth. Remove brush caps with 8-inch screwdriver. Slide all motor and generator brushes in and out, to be sure they move freely and make contact with the commutators. Mark brushes so they can be replaced in the same holder and position. Remove brushes. Inspect for chips, breaks, and wear. New brushes are 1-inch long. Replace if more than half worn or if damaged in any way. Check the operation of the complete traverse (par. 172).

175. REMOVAL AND INSTALLATION OF DRIVE MOTOR OR GEAR BOX.

a. In event of failure of any parts of motor gear box which are not replaceable in the field, remove drive motor and gear box from the vehicle as a unit before removing the motor from the gear box. If drill for drilling dowel pin holes is available, either motor or gear box may be replaced separately. Otherwise motor and gear box must be replaced as a unit.

b. Removal of Motor Gear Box from Vehicle (fig. 27).

BAR, square, 3/8-in.
CONTAINER, oil, 2-qt
COPPER, soldering
PLIERS
SCREWDRIVER, 6-in.
WRENCH, box, 3/8-in.
WRENCH, box, 7/16-in.
WRENCH, socket, 3/4-in., with 8-in. extension

(1) DRAIN OIL FROM GEAR BOX. CAUTION: The oil must always be drained before the gear box is removed from the vehicle. Otherwise the drive motor may be soaked with oil and seriously damaged.

BAR, square, 3/8-in.
CONTAINER, oil, 2-qt
WRENCH, box, 3/8-in.

Turn turret switch to "OFF" position. Remove drain plug (fig. 154) and drain oil into suitable container which will hold at least two quarts. Replace drain plug.

(2) DISCONNECT WIRING (fig. 154).

COPPER, soldering
PLIERS
SCREWDRIVER, 6-in.

Remove three ferrule nuts on drive motor terminal box (pliers).

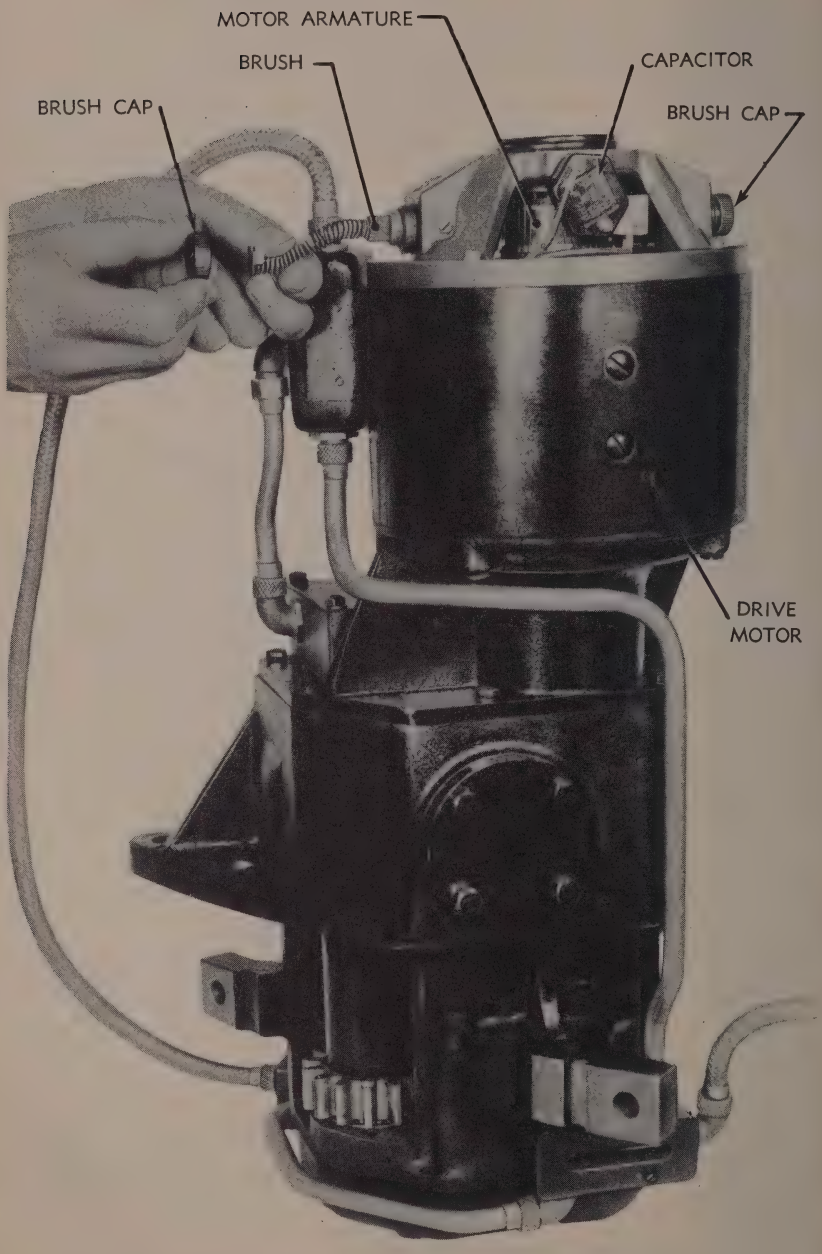


Figure 159—Drive Motor Brush Replacement

Remove drive motor terminal box cover (6-in. screwdriver) and disconnect all wires (soldering copper). Remove cover from generator terminal box with 6-inch screwdriver and disconnect all wires (soldering copper). Remove ferrule nut on generator terminal box (pliers). Shielded cable from generator to gear box is removed with the motor gear box removal.

(3) Remove Mounting Bolts.

WRENCH, socket, 3/4-in., with 8-in. extension

Loosen and remove horizontal mounting bolts (3/4-in. socket wrench, with 8-in. extension), shims, and key, while holding motor gear box in place by hand. Since the motor gear box weighs approximately 185 pounds, this is a two-man operation. Remove two vertical bolts (3/4-in. socket wrench, with 8-in. extension). Lift unit carefully from vehicle. Remove 1/4-inch spacer washers from turret shelf.

(4) Remove Drive Motor from Gear Box (fig. 160).

PLIERS
WRENCH, box, 7/16-in.

Remove eight mounting bolts (7/16-in. box wrench) and lift motor from gear box. Pull two dowel pins from gear box on motor (pliers).

c. Installation of Motor Gear Box in Vehicles.

BAR, square, 3/8-in.
CHISEL, cold
DRILL, size D (0.246-in. diam)
HAMMER
MALLET, rawhide
OIL, engine, seasonal grade (2 qt)
PLIERS
PUNCH, center
SCREWDRIVER, 8-in.
WRENCH, box, 3/8-in.
WRENCH, box, 7/16-in.
WRENCH, socket, 3/8-in., with 8-in. extension

(1) Install Motor Worm.

Fit spacer and key on motor drive shaft. Fit worm on key and tap into place on shaft (rawhide mallet).

(2) Install Motor Tentatively (fig. 160). Place gasket on gear box, and line up holes in gasket with holes in gear box. A little grease between gasket and gear box housing will hold gasket in place. Carefully place motor in position on gear box. Insert mounting bolts finger tight.

(3) Check Backlash (fig. 161).

SCREWDRIVER, 6-in.

Remove motor brush cover. Check backlash between motor drive

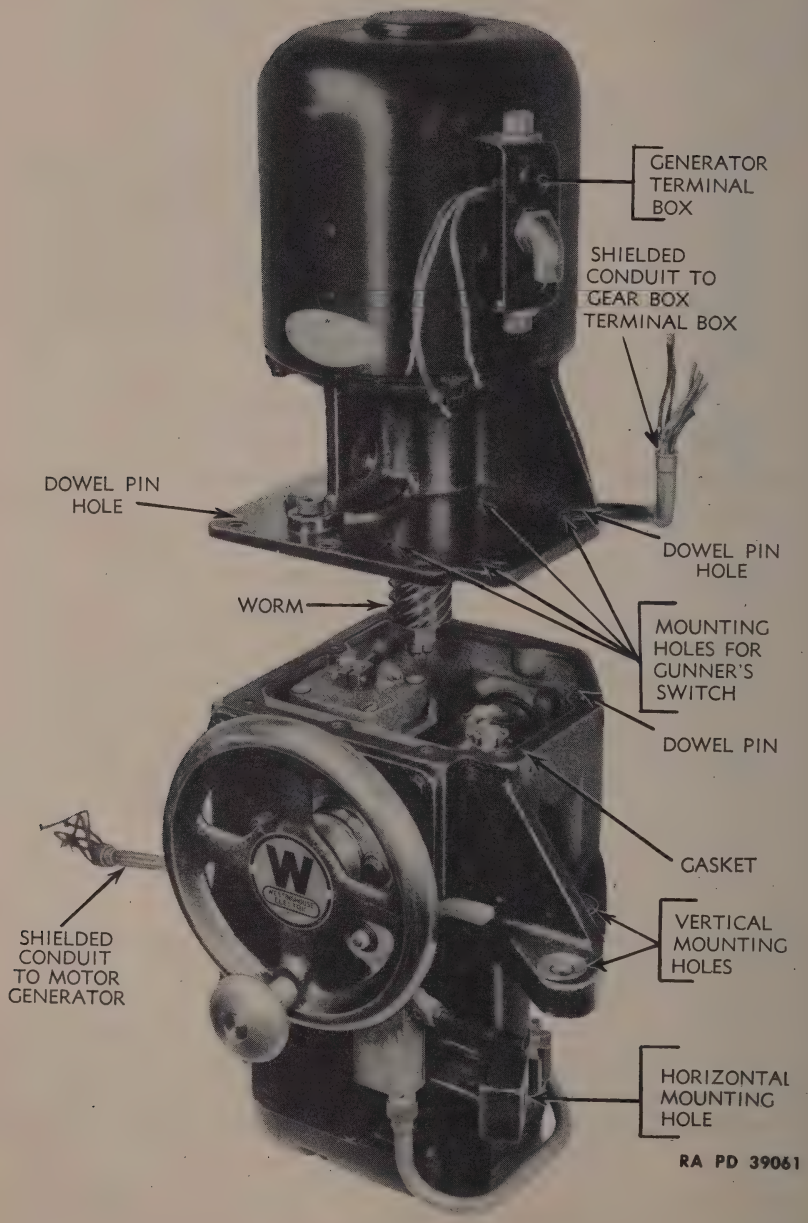


Figure 160—Installation of Motor on Gear Box

ELECTRICAL TURRET TRAVERSING SYSTEM

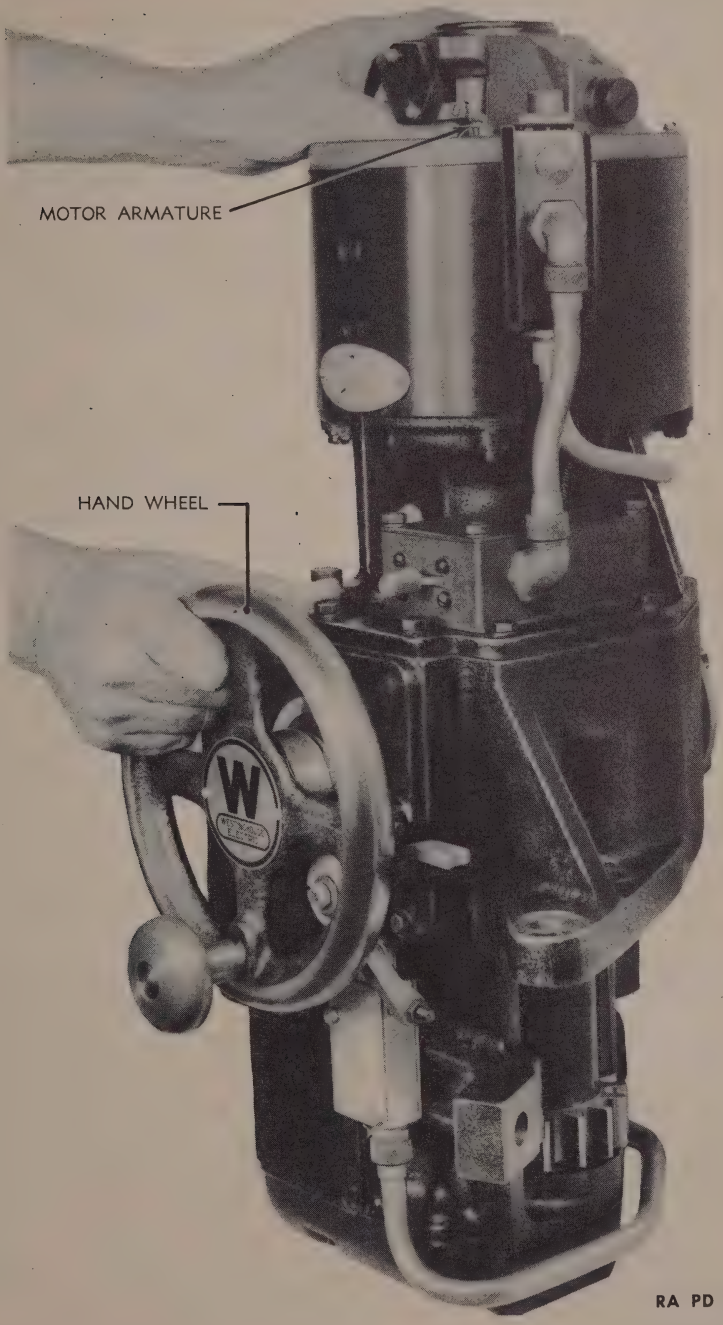


Figure 161—Checking Backlash

worm and shaft worm gear by holding handwheel with one hand and turning motor armature with the other. Move the wheel in steps of approximately 1-inch and recheck at each new position until the handwheel has made one complete revolution. Maximum allowable backlash is $\frac{1}{32}$-inch as measured at the circumference of the commutator. There must be no binding at any point. Shift the position of the motor until the backlash comes within the above limits. Check freedom of motor drive gear and worm shaft by rotating handwheel in manual operation. If binding exists, loosen mounting bolts and readjust.

(4) INSTALL DOWEL PINS.

CHISEL, cold
DRILL, size D
HAMMER
PUNCH, center

If the old dowel pin holes do not line up, remove drive motor. Pound the old dowel pins into the housing hole and cut them off flush with a chisel. Recheck backlash (see previous step). Start dowel pin holes with center punch. Drill new holes $\frac{3}{8}$-inch deep using holes in motor mounting bracket as a guide. Drive in two dowel pins (hammer). If new pins are required, use pins $\frac{5}{8}$-inch long by $\frac{1}{4}$-inch in diam.

(5) INSTALL MOTOR-GEAR BOX IN VEHICLE. Place $\frac{1}{4}$-inch spacer washers over vertical mounting holes on turret ledge. Place key in keyway on turret ring shelf. Place motor-gear box in position on turret ledge. This is a two-man operation. Fit keyway on mounting bracket into place on key. Turn handwheel until proper mesh is obtained between traverse drive gear and turret ring gear. Insert vertical bolts and tighten finger tight.

(6) ADJUST DRIVE GEAR AND TURRET RING GEAR MESH (fig. 155).

WRENCH, socket, $\frac{3}{8}$-in., with 8-in. extension

Install 0.032-inch shim on each horizontal bolt and tighten bolts. Check mesh of traverse drive gear and turret ring gear for backlash and binding while making one complete revolution of turret with handwheel. There must be no binding and no noticeable backlash. The minimum clearance between drive gear and ring gear at the tightest point on the ring gear is 0.002 inch. Correct shims by trial and error until desired adjustment is secured, then tighten vertical bolts permanently ($\frac{3}{4}$-in. socket wrench and 8-in. extension).

(7) CONNECT WIRING (figs. 167, 168, 169 and 170A).

COPPER, soldering
PLIERS
SCREWDRIVER, 6-in.
TAPE, friction
TAPE, rubber

Reconnect wiring at drive motor and generator terminal boxes. Solder

connections securely, cut off excessive ends, and tape, first with rubber tape, then with friction tape. Replace ferrule nuts and terminal box covers.

(8) FILL GEAR BOX WITH OIL.

BAR, 3/8-in. square
OIL, engine, seasonal grade
WRENCH, box, 3/8-in.

Remove oil filler and oil level plugs (3/8-in. square bar and 3/8-in. box wrench). Pour in OIL, engine, seasonal grade, until oil reaches level of oil check plug. Replace plugs.

(9) CHECK THE OPERATION OF THE COMPLETE TRAVERSE (par. 172).

176. REMOVAL AND INSTALLATION OF SILVERSTAT CONTROL (fig. 156).

a. Handle the silverstat control carefully and keep it clean at all times. If the control becomes defective, replace the complete unit. Repairs cannot be made on it.

b. Remove Silverstat Control.

WRENCH, Allen, 3/16-in.

Remove six bottom cover mounting screws. Remove bottom cover and gasket. Remove three silverstat control Allen mounting screws. Remove silverstat control. CAUTION: Handle the silverstat control with care and keep it clean at all times. It is replaceable as a complete assembly only.

c. Install Silverstat Control.

FILE
FLASHLIGHT
GLASS, magnifying, 5-power
WRENCH, Allen, 3/8-in.

Set spacer parallel to handwheel side of gear box by turning worm shaft. Feed silverstat control leads into terminal box while placing silverstat control into position. The leads cannot be inserted after control has been placed in position. Slide insulated buttons over spacer as silverstat control nears its final position. Place lock washers and mounting bolts in position and tighten bolts finger tight. Mounting holes in silverstat cradle are oversize. Using five-power magnifying glass and flashlight, shift cradle until spacer centers with no leaves closed. File posts on insulated buttons, if necessary, but be sure not to file posts any more than necessary to open closed contacts. Posts should touch one leaf on each side but not close any leaves with spacer in neutral. Tighten mounting screws (3/8-in. Allen wrench).

177. REMOVAL AND INSTALLATION OF HANDWHEEL (figs. 162 and 163).

a. Remove Handwheel (Westinghouse Traverse Style No. 1231700).

SCREWDRIVER, 4-in. SCREWDRIVER, 8-in.

Early models were equipped with a metal handwheel, later models have a plastic handwheel with fold-away handle. The procedure for removing both is the same. Remove screws and name plate on handwheel with 4-inch screwdriver. Remove four mounting screws, wheel, and gasket (8-in. screwdriver).

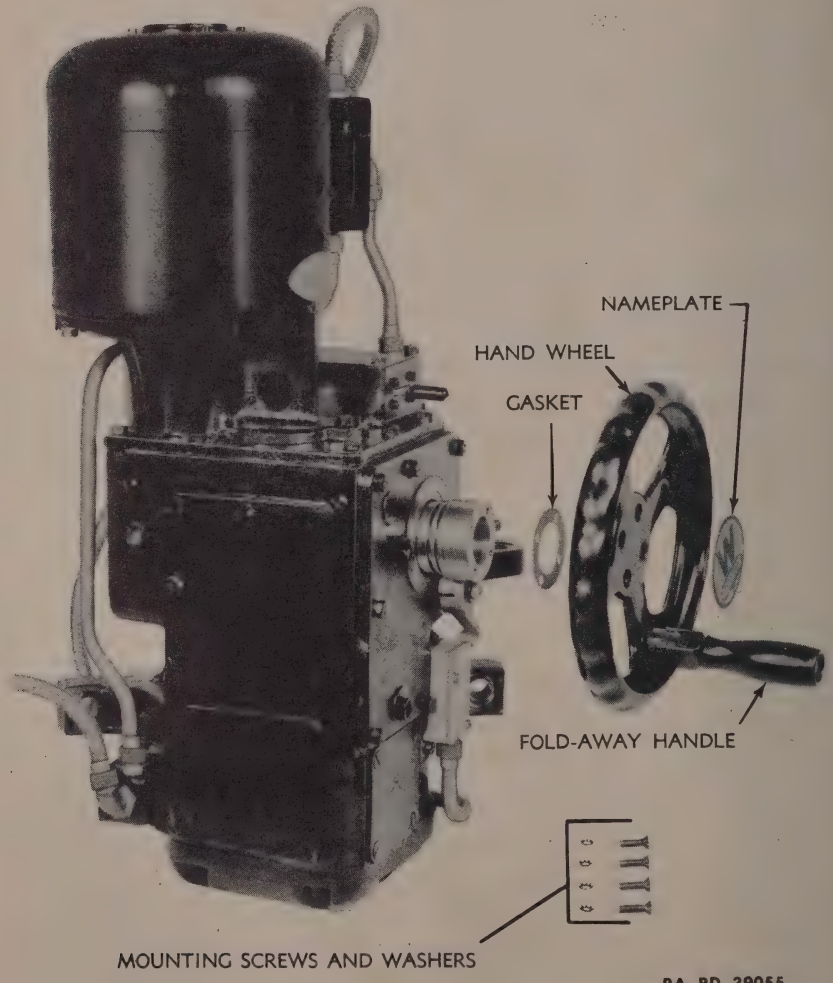


Figure 162—Removal of Handwheel

HANDWHEEL, PLASTIC, WITH DETACHABLE HUB STYLE 1231700

HANDWHEEL, PLASTIC, WITH ATTACHED HUB STYLE 1234375

STYLE 1231700

RA PD 39102

Figure 163—Three Types of Handwheels

b. Remove Handwheel (Westinghouse Traverse Style No. 1234375).

WRENCH, box, ¾-in.

This procedure is the same as that outlined above except the handwheel is attached by an elastic stop nut (¾-in. box wrench) and there is no name plate.

c. Install Handwheel (Westinghouse Traverse Style No. 1231700).

HAMMER
PUNCH, center
SCREWDRIVER, 4-in.
SCREWDRIVER, 8-in.
WRENCH, open-end, 7/16-in.

Install wheel on hub with four mounting screws (8-in. screwdriver). Stake screws (center punch and hammer). Install name plate with two screws (4-in. screwdriver). Adjust lock lever disengaging arm adjusting screw so the plunger of the disengaging switch will protrude not more than 1/16-inch in manual operation (4-in. screwdriver and 7/16-in. open-end wrench). In electrical operation the adjusting screw must not touch the switch plunger. Adjust the lock arm adjusting screw so the lock arm will clear the hub when changing from one type of operation to the other.

d. Install Handwheel (Westinghouse Traverse Style No. 1234375).

WRENCH, socket, ¾-in.

This procedure is the same as outlined in the preceding step except the handwheel slips over the short shaft and is fastened with one elastic stop nut, and there is no name plate.

178. REMOVAL AND INSTALLATION OF FRONT COVER, OIL SEAL, HANDWHEEL HUB, IDLER GEAR, OR LOCK LEVER.

a. Remove and Disassemble Front Cover with Detachable Hub (Westinghouse Style No. 1231700) (figs. 164 and 165). CAUTION: Do not disassemble unless necessary. This complete assembly is interchangeable.

DRIFT, soft metal
HAMMER, light
PLIERS
SCREWDRIVER, 4-in.
SCREWDRIVER, 6-in.
WRENCH, box, ½-in.
WRENCH, box, 9/16-in.
WRENCH, open-end, 7/16-in.

Remove oil drain plug and drain oil into a clean container. Reinstall oil drain plug. Remove seven mounting bolts and lock washers with 7/16-inch open-end wrench. Remove front cover. If necessary to disassemble front cover proceed as follows: Remove lock lever mounting

Figure 164—Two Types of Front Cover (Front)

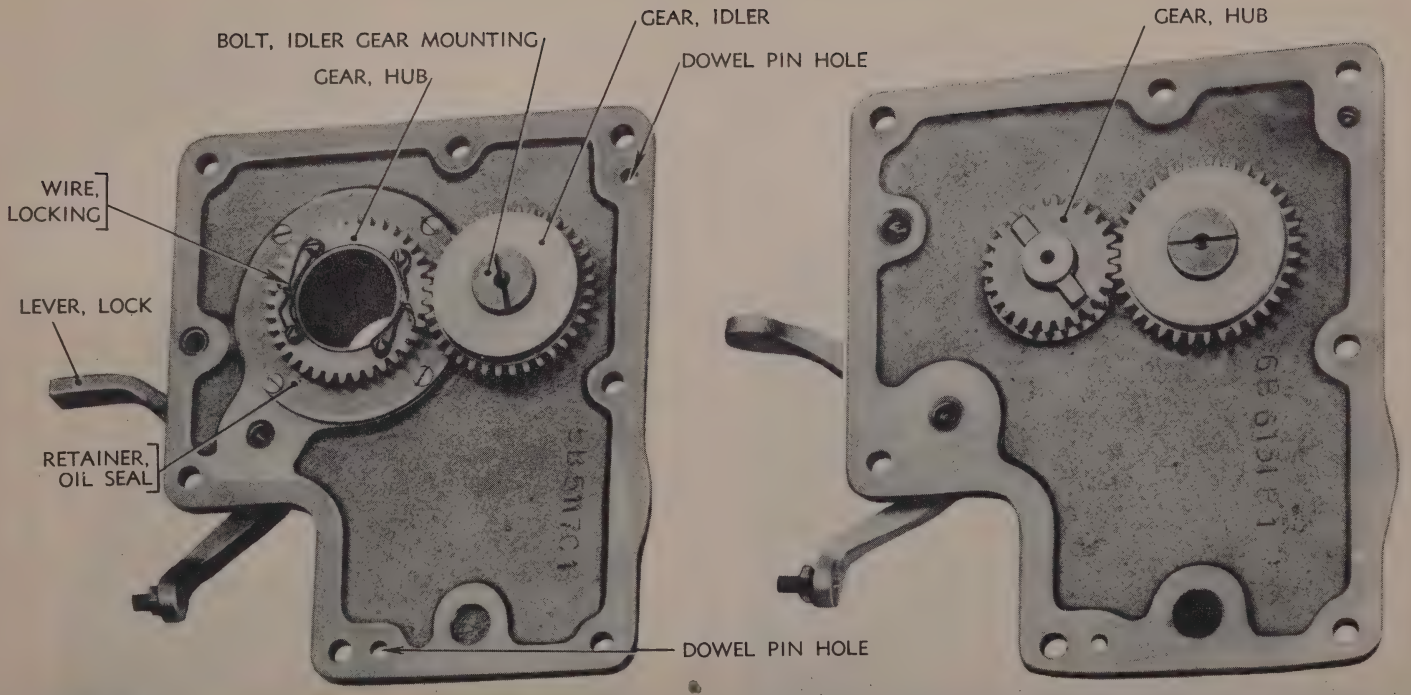


Figure 165—Two Types of Front Cover (Rear)

bolt nut, washer, and spacer (½-in. box wrench). Remove lock lever, spring, and spacer. Remove lock wire on hub gear mounting screws (pliers). Remove hub gear mounting screws (4-in. screwdriver). Remove hub gear and hub. Remove four screws from oil seal retainer (6-in. screwdriver). Remove retainer. Remove oil seal with soft metal drift and light hammer. Hold idler gear with screwdriver and remove nut (9/16-in. box wrench). Remove mounting bolt and idler gear.

b. Remove and Disassemble Front Cover with Hub Attached to Handwheel (Westinghouse Style No. 1234375) (figs. 164 and 165). This procedure is the same as that described in the preceding step except that the hub gear is a part of the short shaft and is free to be removed as soon as the handwheel and front cover are removed, and there is no oil seal retainer.

c. Assemble Front Cover with Detachable Hub (Westinghouse Style No. 1231700) (figs. 164 and 165).

HAMMER	SCREWDRIVER, 4-in.
MALLET, rawhide	SCREWDRIVER, 6-in.
PLIERS	WRENCH, box, ½-in.
PUNCH, center	WRENCH, box, 9/16-in.

Tap oil seal into position with rawhide mallet. Install idler gear, rounded tooth side away from cover (6-in. screwdriver and 9/16-in. box wrench). Assemble lock lever. Place spring in recess on lever with straight end in lever slot and bent end in small hole near mounting stud. Install bolt, add spacer and washer, and tighten elastic stop nut (½-in. box wrench). Install oil seal retainer plate (6-in. screwdriver) and stake screws (center punch and hammer). Hold down lock lever and insert hub through hole in front cover with grooves on lever side. Place hub gear on hub with rounded teeth side next to cover. These rounded teeth facilitate meshing with the idler gear. Insert screws and tighten (4-in. screwdriver). Lock screws with locking wire (pliers). Be sure hub turns freely.

d. Install Front Cover with Detachable Hub (Style No. 1234375) (fig. 157).

CHISEL, cold	HAMMER
DRILL, size D (0.246-in. diam)	PUNCH, center
	WRENCH, box, 7/16-in.

Position front cover in oversize mounting holes so there is no binding between idler gear and flange spur gear. Turn hub to check. Screw in seven mounting bolts finger tight. If the original dowel pin holes do not line up, remove front cover. Pound dowel pins into housing holes and cut them off with a chisel. Replace front cover and recheck for binding. When cover is properly adjusted start dowel pin holes with center punch

and hammer. Drill new holes 3/8-inch deep using holes in front cover as a guide. If hub turns tight, put one drop of oil on oil seal. Tighten four front cover corner mounting bolts (7/16-in. box wrench). Tighten remaining three front cover mounting bolts. Recheck mesh of idler gear and flange spur gear to be sure tightening front cover did not make gears bind. Install dowel pins 5/8-inch long by 1/4-inch in diameter.

e. Assemble and Install Front Cover (With Hub Gear Short Shaft). The procedure for assembly and installation is the same as that for models with detachable hub except as follows: The hub gear is attached to a short shaft on which the handwheel mounts. There is no oil seal retainer.

f. Install Side Cover, and Gyro Side and Front Covers.

SCREWDRIVER, 8-in. WRENCH, crescent, 8-in.

Put gasket on cover. Stick gasket to cover with small spot of grease. Place countersinks of holes out. Put lock washers on screws, and screw cover to housing. Tighten screws firmly by turning screwdriver with 8-inch crescent wrench, or equivalent. Repeat above operation for gyro front and side covers. Remove oil filler and check plugs. Refill with OIL, engine, seasonal grade, until oil reaches level of oil check plug. Reinstall oil filler and check plugs.

179. REMOVAL AND INSTALLATION OF FLANGE AND GEAR ASSEMBLY (fig. 166).

a. Remove Gears and Flange.

SCREWDRIVER, 8-in. WRENCH, box, 7/16-in.

Remove oil drain plug and drain oil into clean container. Reinstall oil drain plug. Turn turret switch to "OFF" position. Remove seven mounting cap screws (7/16-in. box wrench) and front cover assembly. Line up holes in flange spur gear with screws in flange and remove four screws (8-in. screwdriver). Remove gears and flange and shims, if any, between flange and gear box housing. Save and protect shims if parts are to be replaced.

b. Install Gears and Flange.

HAMMER SCREWDRIVER, 8-in.
PUNCH, center WRENCH, box. 7/16-in.

Check to be sure flange rotates freely on differential bevel gear shaft. If flange does not rotate freely and without looseness, replace it. Install assembly in housing (push fit) so flange is flush against housing. Check for backlash between differential bevel gear and flange bevel

ELECTRICAL TURRET TRAVERSING SYSTEM

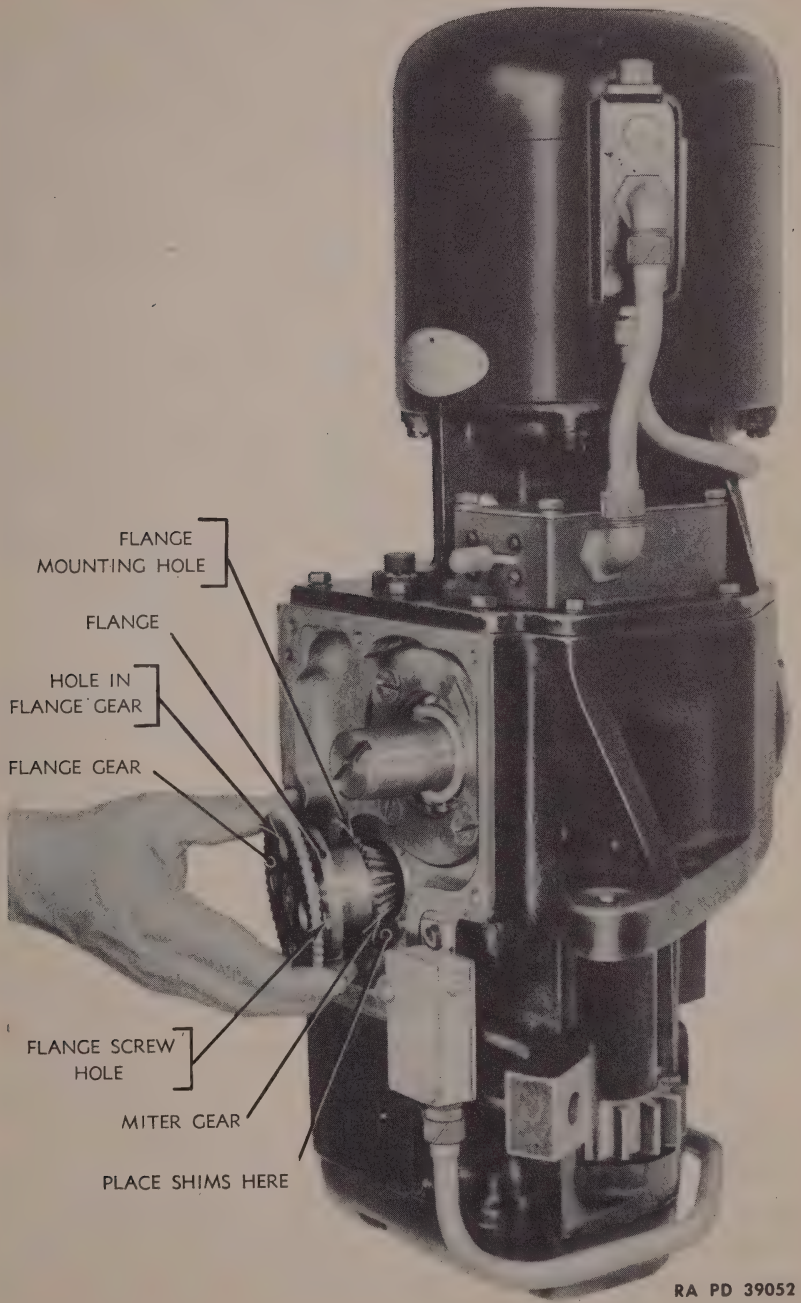


Figure 166—Installing Flange and Gear Assembly

gear by holding one and rotating the other slightly. If tight, add 0.005-inch shims until slight backlash is obtained. Line up holes in flange straight gear, flange, and gear box. Insert four screws and tighten (8-in. screwdriver). Stake screws (hammer and center punch). Reinstall front cover assembly ($\frac{7}{16}$-in. box wrench). Remove oil filler and check plugs. Refill with OIL, engine, seasonal grade, until oil reaches level of oil check plug. Reinstall oil filler and check plugs.

180. REPLACING COMMANDER'S SWITCH (figs. 32, 167 and 168A).

a. Turn turret switch to "OFF" position.

b. Remove screws from cover of drive motor terminal box and remove cover.

c. Disconnect wires from commander's switch conduit.

d. Remove shielded conduit ferrule nut.

e. Remove mounting bolts and commander's switch. The switch and attached shielded conduit are replaceable as a unit.

f. To install replacement switch, reverse the above procedure. Follow wiring diagram and wiring chart for electrical connections.

g. Check operation of switch and complete traverse.

181. REPLACING GUNNER'S SWITCH (figs. 167, 168, 169 and 170).

a. Turn turret switch to "OFF" position.

b. Disconnect steel tube ferrule nut at drive motor terminal box.

c. Remove cover of terminal box and disconnect wires to switch.

d. Remove four mounting bolts in cover of gunner's switch and remove switch and steel conduit tubing as a unit.

e. Remove spacer washers between switch and gear box.

f. To install replacement unit, reverse the removal procedure. Follow wiring diagram and wiring chart for electrical connections.

g. Check operation of switch and complete traverse.

182. REPLACING WIRING (figs. 167, 168, 169 and 170).

a. The wiring and shielded conduit attached to the gunner's and commander's switches are replaceable as a unit with the switches. The wiring and steel tubing running from the traverse drive motor terminal box and the gear box terminal box are replaceable as a unit. For all wiring connections see wiring diagram. For pictorial view of connections in the drive motor and gear box terminal boxes, see the wiring chart.

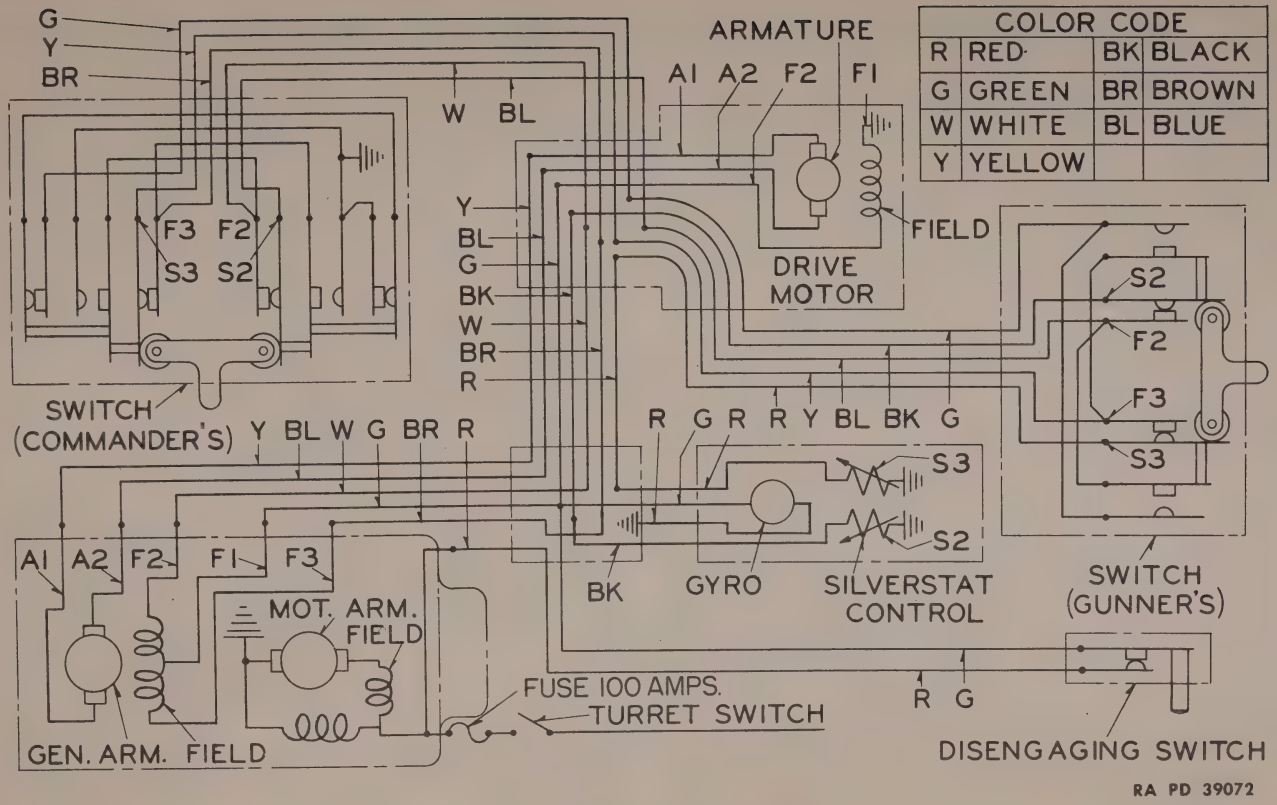


Figure 167—Wiring Diagram for Traverse Style No. 1231700

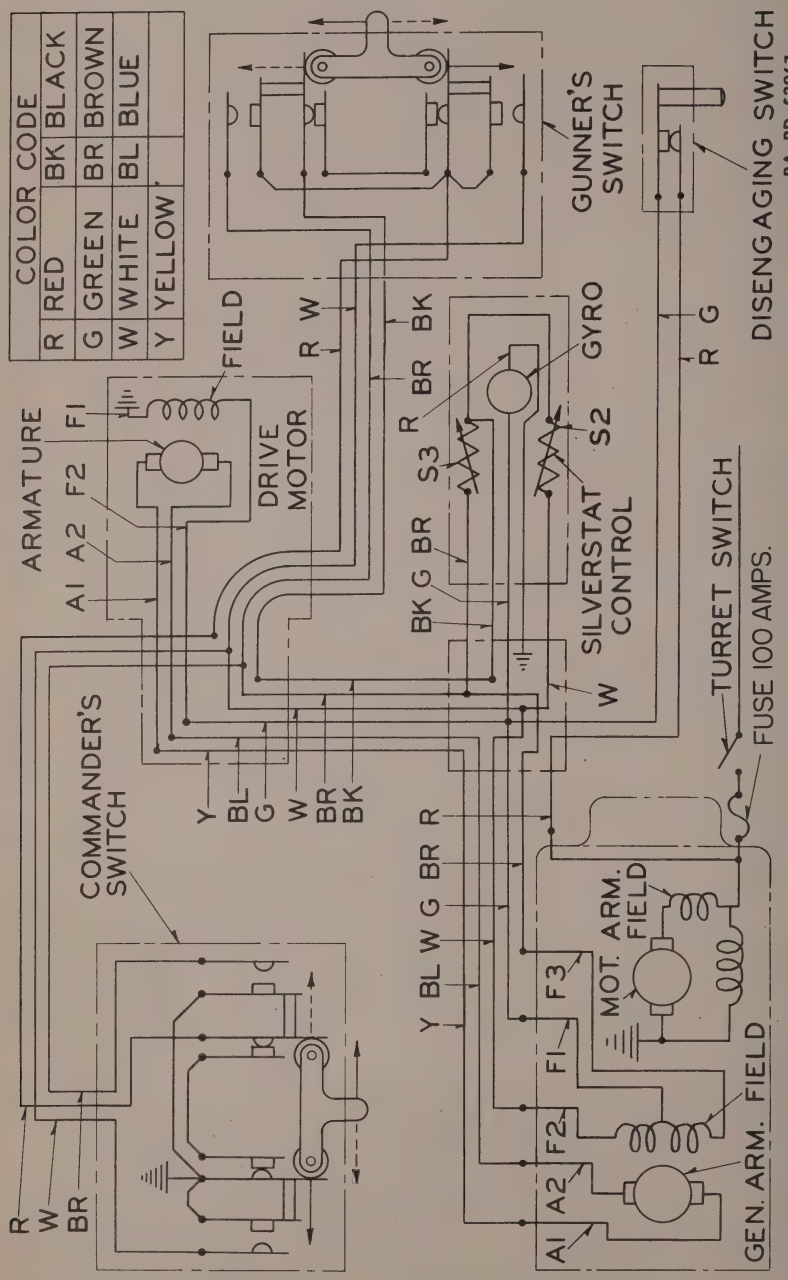


Figure 168—Wiring Diagram for Traverse Style No. 1234375

ELECTRICAL TURRET TRAVERSING SYSTEM

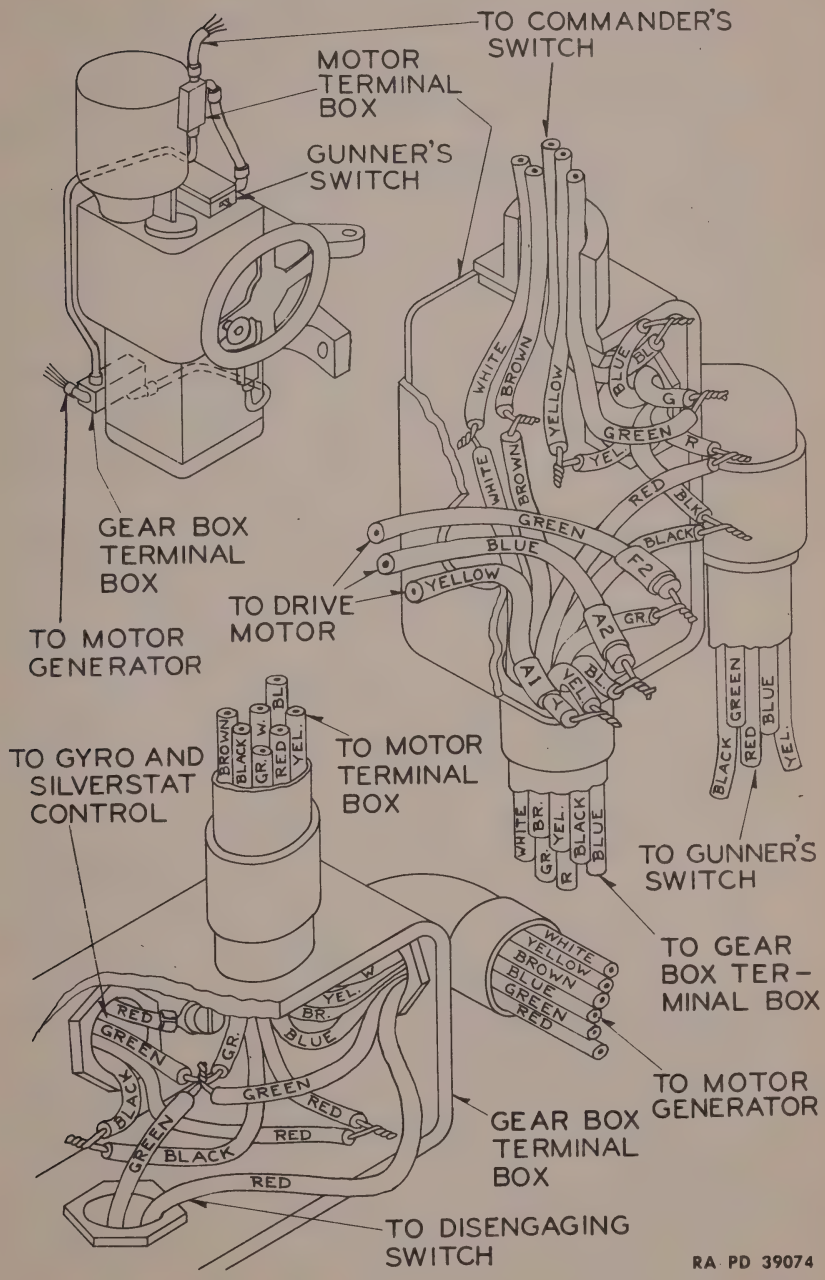


Figure 169—Wiring Chart for Traverse Style No. 1231700

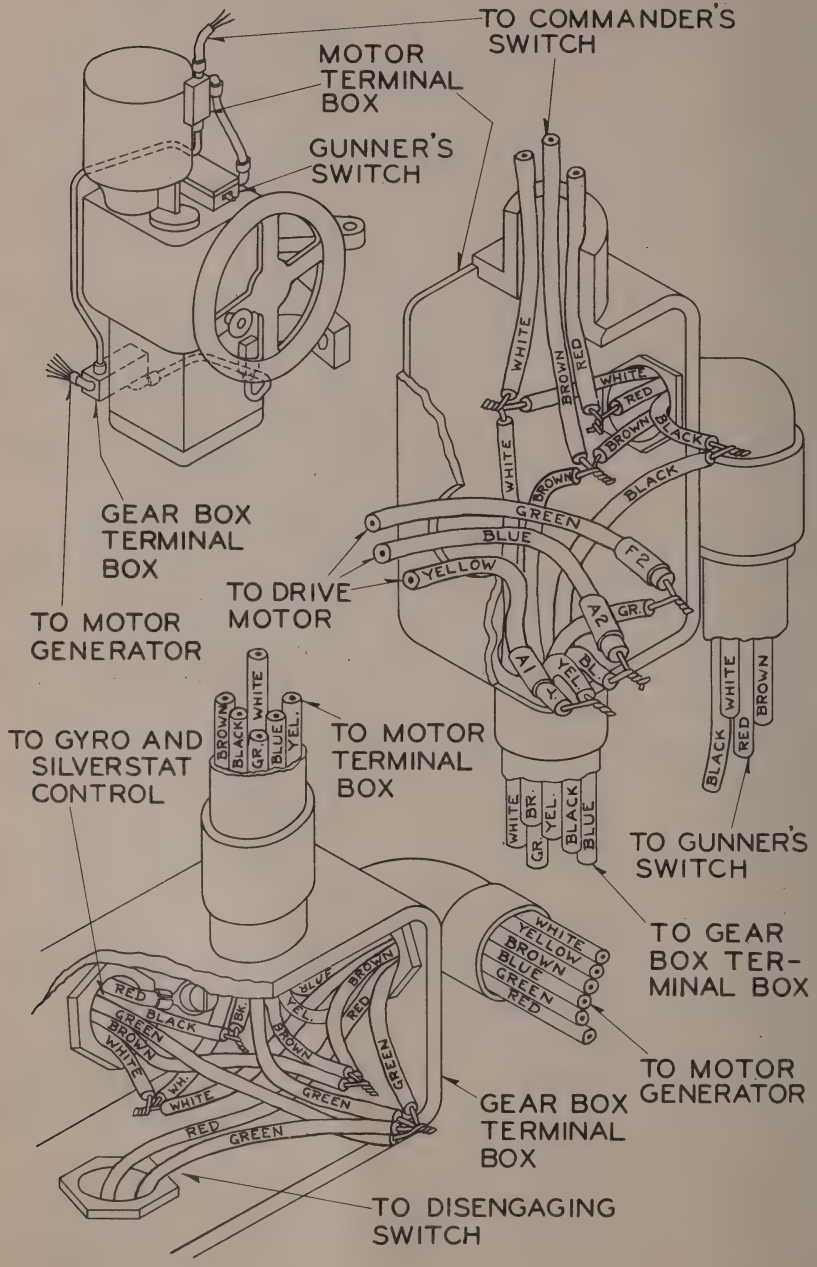


Figure 170—Wiring Chart for Traverse Style No. 1234375

b. The shielded conduit between motor generator and gear box terminal boxes, and between commander's switch and traverse motor terminal box is flexible; all other conduit is rigid.

c. To Replace Wiring and Shielded Conduit.

(1) Remove ferrule nut at both ends of flexible or steel conduit terminal boxes.

(2) Remove terminal box covers.

(3) Disconnect both ends of damaged wire.

(4) Bare one end of replacement wire of its insulation and splice it to the wire which is to be replaced.

(5) Pull out faulty wire from conduit which automatically threads it with the new wire at the same time.

(6) Disconnect new wire from old.

(7) Cut new wire to proper length.

(8) Connect new wire to proper places in terminal boxes.

(9) Reinstall terminal box covers and ferrule nuts.

d. To Replace Damaged Conduit.

(1) Remove ferrule nuts from terminal boxes at both ends of conduit.

(2) Remove covers from terminal boxes.

(3) Disconnect wires of cable in both terminal boxes and remove conduit from unit.

(4) Replace new conduit in the reverse order of removal.

(5) Reinstall and reconnect wires (figs. 167, 168, 169 and 170).

(6) Check the operation of the complete traverse.

183. REPLACING DISENGAGING SWITCH (fig. 154).

a. Removing Switch.

(1) Turn turret switch to "OFF" position.

(2) Remove switch cover and disconnect wires.

(3) Unscrew ferrule nut from switch.

(4) Remove mounting screws and switch.

b. Installing Replacement Switch.

(1) To install replacement unit, reverse removal procedure.

(2) Adjust lock lever stop so lock lever flange will just clear handwheel hub flanges when lever is depressed.

(3) Adjust disengaging switch adjusting screw so plunger will be all the way out in power operation and not protrude more than $\frac{1}{16}$-inch in manual operation.

(4) Check the operation of the complete traverse.

MEDIUM TANKS M4 AND M4A1

Section XXVI

HYDRAULIC TRAVERSING MECHANISM

Paragraph

Removing upper assembly (hydraulic motor, manual drive and gear mechanism) 184
Replace hydraulic motor 185
Replace handwheel extension 186
Install upper assembly 187
Remove lower assembly (Electric Motor Pump, Control Valve, Oil Reservoir) 188
Remove control valve 189
Install control valve 190
Remove hydraulic pump 191
Install hydraulic pump 192
Remove electric motor 193
Install electric motor 194
Remove oil reservoir 195
Install oil reservoir 196
Install lower assembly 197

184. REMOVING UPPER ASSEMBLY (HYDRAULIC MOTOR, MANUAL DRIVE AND GEAR MECHANISM).

a. Equipment.

WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, socket, with L-handle, 3/4-in.
WRENCH, socket, with 6-in. extension, 15/16-in.

b. Procedure.

(1) DISCONNECT MOTOR TUBES (fig. 171).

WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/16-in.

Loosen lock nuts with 1-inch open-end wrench. Disconnect both motor tubes at hydraulic motor with 1 1/16-inch open-end wrench. Lower tubes to floor of tank.

(2) DISCONNECT MOTOR DRAIN TUBE.

WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.

Loosen lock nut with 9/16-inch open-end wrench. Disconnect motor

HYDRAULIC TRAVERSING MECHANISM

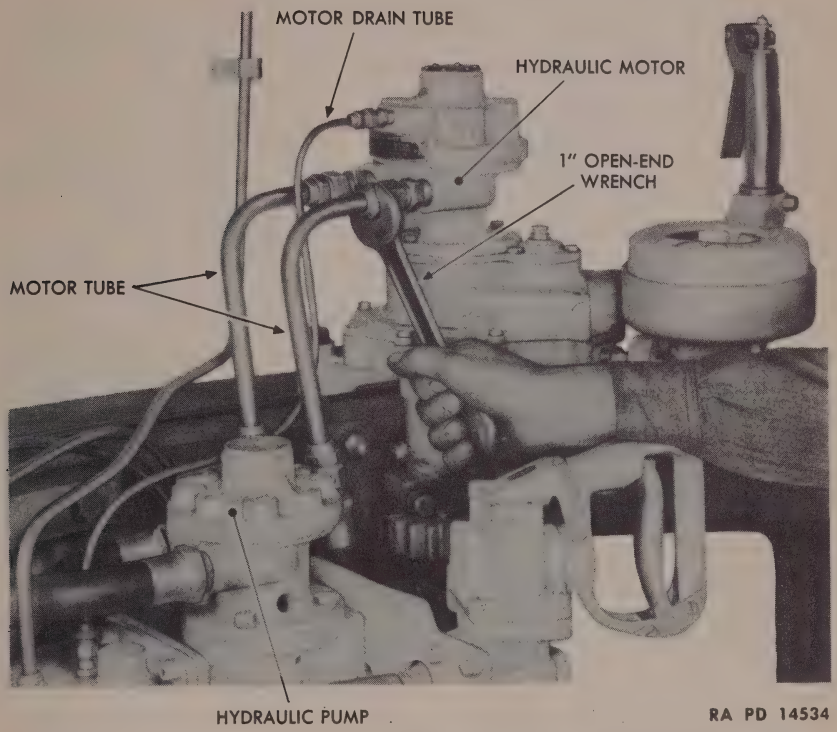


Figure 171—Removing Motor Tubes from Hydraulic Motor—Hydraulic Turret Traversing Mechanism

drain tube from connector in hydraulic motor, using $\frac{5}{8}$-inch open-end wrench.

(3) REMOVE LOWER CAP SCREW (fig. 172).
WRENCH, socket, with L-handle, $\frac{3}{4}$-in.

With $\frac{3}{4}$-inch L-handle socket wrench, remove the two cap screws and lock washers at lower end of gear case.

(4) REMOVE UPPER CAP SCREWS (fig. 173).
WRENCH, socket, $1\frac{5}{16}$-in., with 6-in. extension

Support handwheel extension on knee while removing right upper cap screws. Using $1\frac{5}{16}$-inch socket wrench with 6-inch extension; remove both cap screws, lock washers and spacers.

(5) Lift off entire upper assembly. Lift out case shim and take out case key (fig. 174).

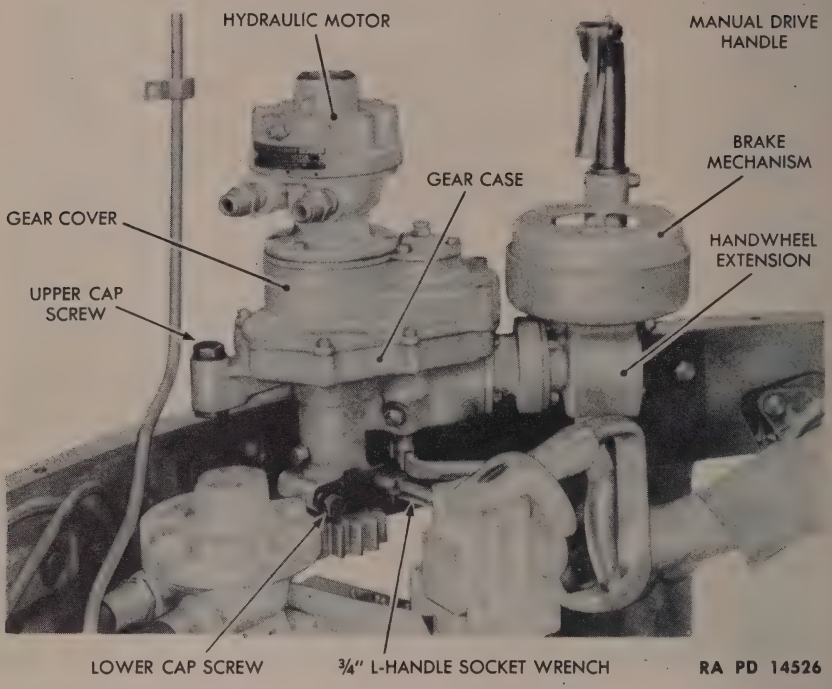


Figure 172—Removing Lower Cap Screws, Upper Assembly—Hydraulic Turret Traversing Mechanism

185. REPLACE HYDRAULIC MOTOR.

a. Equipment.

WRENCH, box, $\frac{7}{16}$-in.

b. Procedure.

(1) REMOVE HYDRAULIC MOTOR FROM GEAR COVER (fig. 174).

WRENCH, box, $\frac{7}{16}$-in.

Using $\frac{7}{16}$-inch box wrench, remove the four cap screws and lock washers that hold hydraulic motor to gear cover. Lift off motor.

(2) INSTALL HYDRAULIC MOTOR ON GEAR COVER.

WRENCH, box, $\frac{7}{16}$-in.

Place new motor in position on top of gear cover, with ports facing to left and splined shaft of motor engaging gear inside cover. Install the four cap screws and lock washers and tighten with $\frac{7}{16}$-inch box wrench.

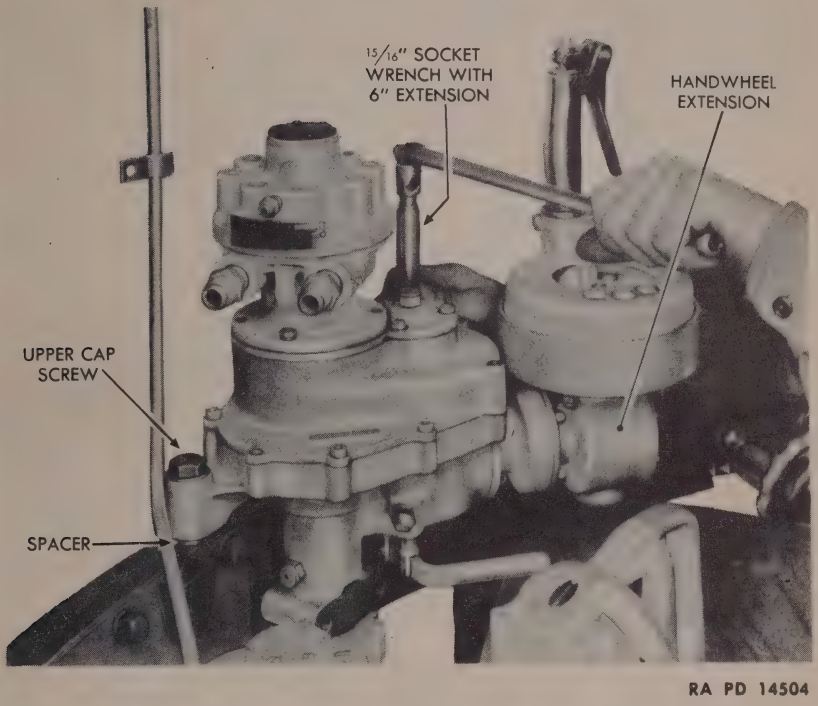


Figure 173—Removing Upper Cap Screws, Upper Assembly—Hydraulic Turret Traversing Mechanism

186. REPLACE HANDWHEEL EXTENSION (fig. 175).

a. Equipment.

WRENCH, box, 7/16-in.

b. Procedure.

(1) REMOVE HANDWHEEL EXTENSION AND BRAKE MECHANISM (fig. 175). Using 7/16-inch box wrench, remove the four nuts from studs in gear case. Remove handwheel extension and gear mechanism as an assembly.

(2) INSTALL HANDWHEEL EXTENSION AND BRAKE MECHANISM. Place flange of handwheel extension in position over studs in gear case with manual drive handle pointing in opposite direction from pinion. Install nuts on studs and tighten with 7/16-inch box wrench.

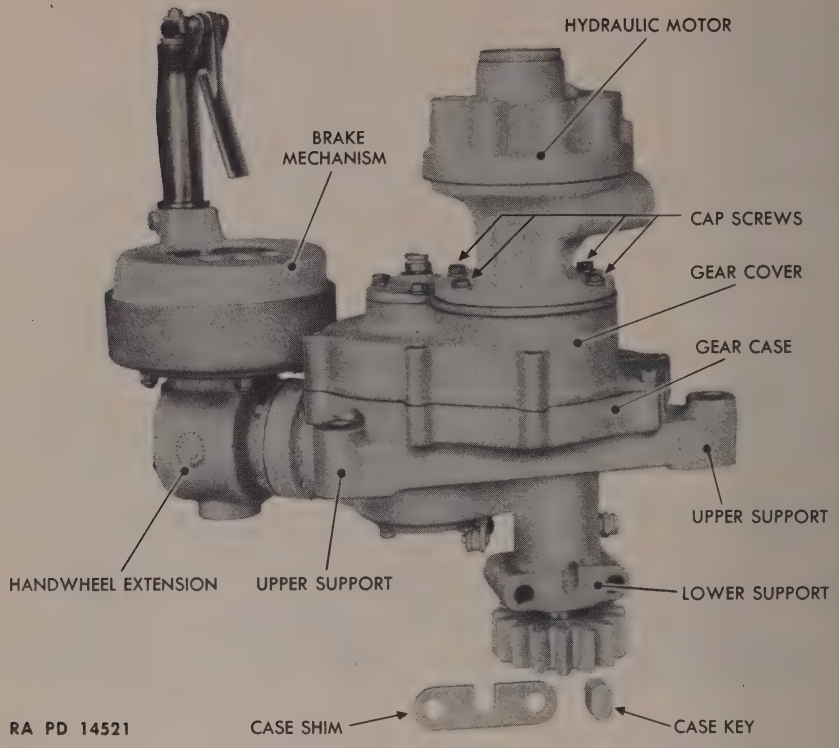


Figure 174—Rear View of Upper Assembly Removed from Tank—Hydraulic Turret Traversing Mechanism

187. INSTALL UPPER ASSEMBLY.

a. Equipment.

WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 15/16-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, socket, with L-handle, 3/4-in.

b. Procedure.

(1) Insert the two shorter (2½-in. long) cap screws with lock washers in upper gear case supports. Place spacer over end of each cap screw, lift assembly into position and start the two upper cap screws.

(2) Insert case key in slot (fig. 174) and slip case shim into position. Insert the two longer (3-in. long) cap screws with lock washers through lower case support and shim.

HYDRAULIC TRAVERSING MECHANISM

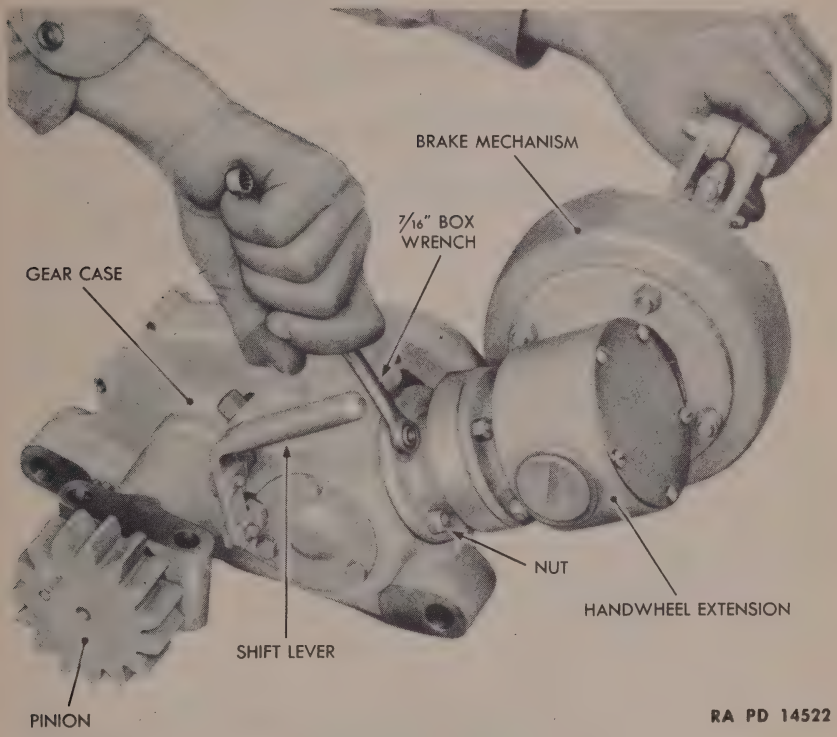


Figure 175—Removing Handwheel Extension and Brake Mechanism Assembly from Gear Case—Hydraulic Turret Traversing Mechanism

(3) Using $1\frac{5}{16}$-inch socket wrench with 6-inch extension, tighten upper cap screws. Tighten lower cap screws, using $\frac{3}{4}$-inch L-handle socket wrench.

(4) INSTALL MOTOR TUBES (fig. 171).

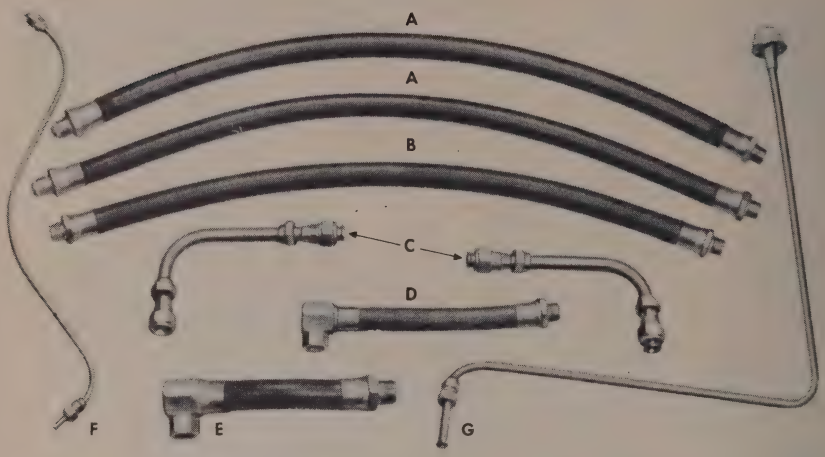
WRENCH, open-end, 1-in. WRENCH, open-end, $1\frac{1}{16}$-in.

Start motor tubes on connectors in hydraulic pump. Be sure inner port of motor is connected to inner port of control valve and that hoses do not cross. Tighten tubes on connectors in motor with a $1\frac{1}{16}$-inch open-end wrench. Tighten lock nuts with 1-inch open-end wrench.

(5) INSTALL MOTOR DRAIN TUBE (fig. 171).

WRENCH, open-end, $\frac{5}{8}$-in. WRENCH, open-end, $\frac{9}{16}$-in.

Start motor drain tube onto connector in hydraulic motor. Tighten with $\frac{5}{8}$-inch open-end wrench. Tighten lock nut with $\frac{9}{16}$-inch open-end wrench.



A—MOTOR HOSES, CONTROL VALVE TO MOTOR TUBES. 34½ IN. LONG
B—PRESSURE HOSE, HYDRAULIC PUMP TO CONTROL VALVE. 31 IN. LONG
C—MOTOR TUBES, MOTOR HOSES TO HYDRAULIC MOTOR
D—RETURN HOSE, CONTROL VALVE TO OIL RESERVOIR
E—SUCTION HOSE, OIL RESERVOIR TO HYDRAULIC PUMP
F—MOTOR DRAIN TUBE, HYDRAULIC MOTOR TO RESERVOIR
G—BREATHER TUBE, INSTALLED TOP OF OIL RESERVOIR

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Figure 176—Hoses and Tubes—Hydraulic Turret Traversing Mechanism

188. REMOVE LOWER ASSEMBLY (ELECTRIC MOTOR, PUMP, CONTROL VALVE, OIL RESERVOIR).

a. Equipment.

SCREWDRIVER
WRENCH, Allen, 3/8-in.
WRENCH, box, 7/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 3/4-in.

b. Procedure.

(1) DISCONNECT STABILIZER PUMP (fig. 30).

WRENCH, box, 7/16-in.

Using 7/16-inch box wrench, remove the four cap screws and lock washers that holding stabilizer pump to lower bracket of electric motor.

(2) REMOVE BREATHER TUBE (fig. 29).

SCREWDRIVER
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 3/4-in.

(a) Using 1 1/16-inch open-end wrench, loosen lock nut on breather tube at connection on top of oil reservoir. With 3/4-inch wrench, disconnect breather tube.

(b) With screwdriver, remove clip that holds breather tube to wall of turret. Remove breather tube.

(3) DISCONNECT MOTOR TUBES FROM HYDRAULIC MOTOR (par. 184 b (1)).

(4) DISCONNECT MOTOR DRAIN TUBE (par. 184 b (2)).

(5) REMOVE LOWER ASSEMBLY (fig. 177).
WRENCH, Allen, 3/8-in.

With one man supporting lower assembly from inside turret basket, remove lower first and then upper socket-head screws that hold assembly to wall of basket, using 3/8-inch Allen wrench. Lift assembly out, leaving stabilizer pump in place.

189. REMOVE CONTROL VALVE.

a. Equipment.

WRENCH, Allen, 5/16-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/8-in.
WRENCH, open-end, 1 3/16-in.
WRENCH, open-end, 1 1/2-in

b. Procedure.

(1) REMOVE MOTOR HOSES (fig. 178).
WRENCH, open-end, 1 1/2-in.

Disconnect motor tubes at hydraulic motor (par. 184 b (1)). Using 1 1/2-inch open-end wrench, remove motor hoses from lower ports in control valve.

(2) REMOVE EXHAUST HOSE (fig. 178).
WRENCH, open-end, 1 1/8-in.
WRENCH, open-end, 1 3/16-in.

Disconnect exhaust hose at oil reservoir, using 1-inch open-end wrench. Remove exhaust hose from control valve with 1 3/16-inch open-end wrench.

(3) DISCONNECT PRESSURE HOSE (fig. 178).
WRENCH, open-end, 1-in.

Using 1-inch open-end wrench, disconnect pressure hose from control valve.

(4) REMOVE CONTROL VALVE (fig. 179).
WRENCH, Allen, 5/16-in.

Using 5/16-inch Allen wrench, remove the four screws that hold control valve to control valve bracket. Lift off valve.

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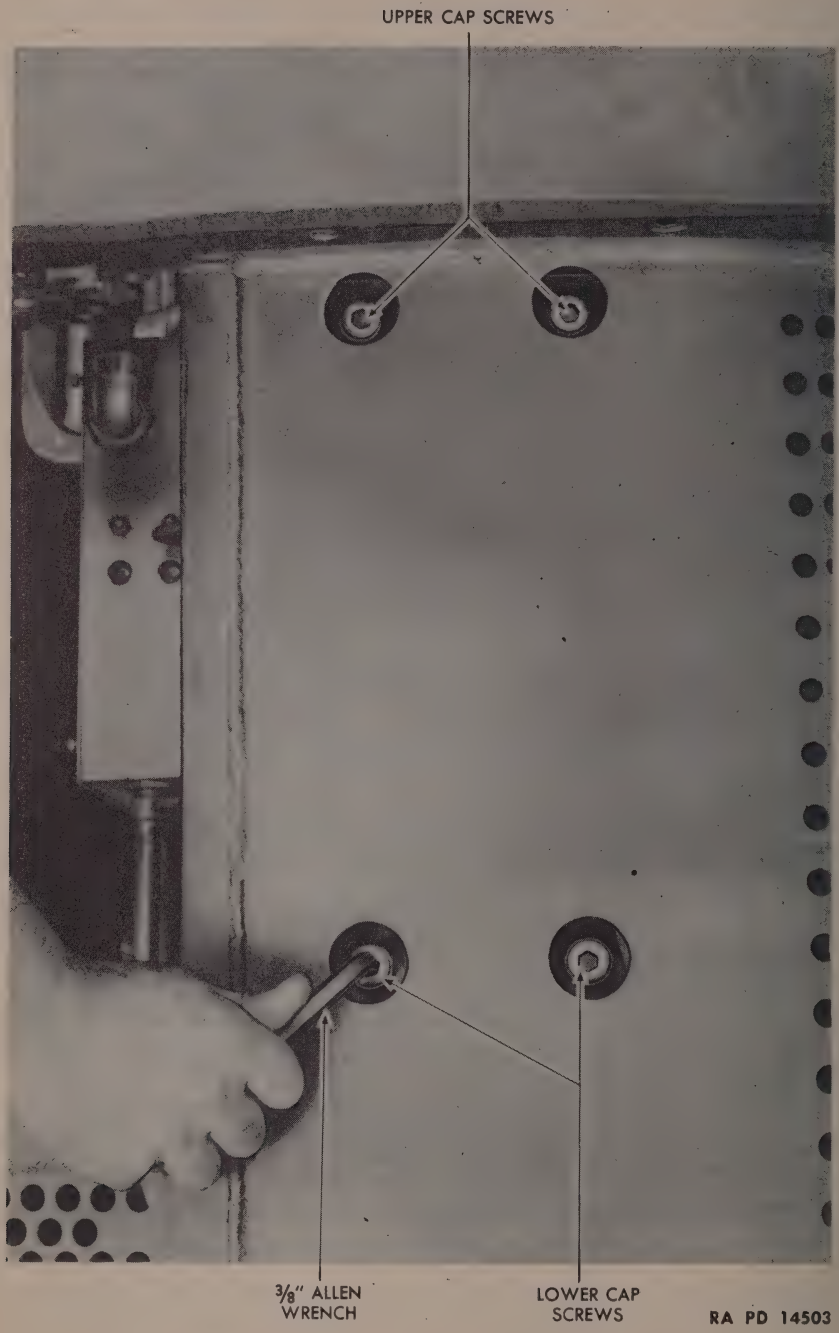

Figure 177—Removing Lower Assembly Attaching Screws—Hydraulic Turret Traversing Mechanism

HYDRAULIC TRAVERSING MECHANISM

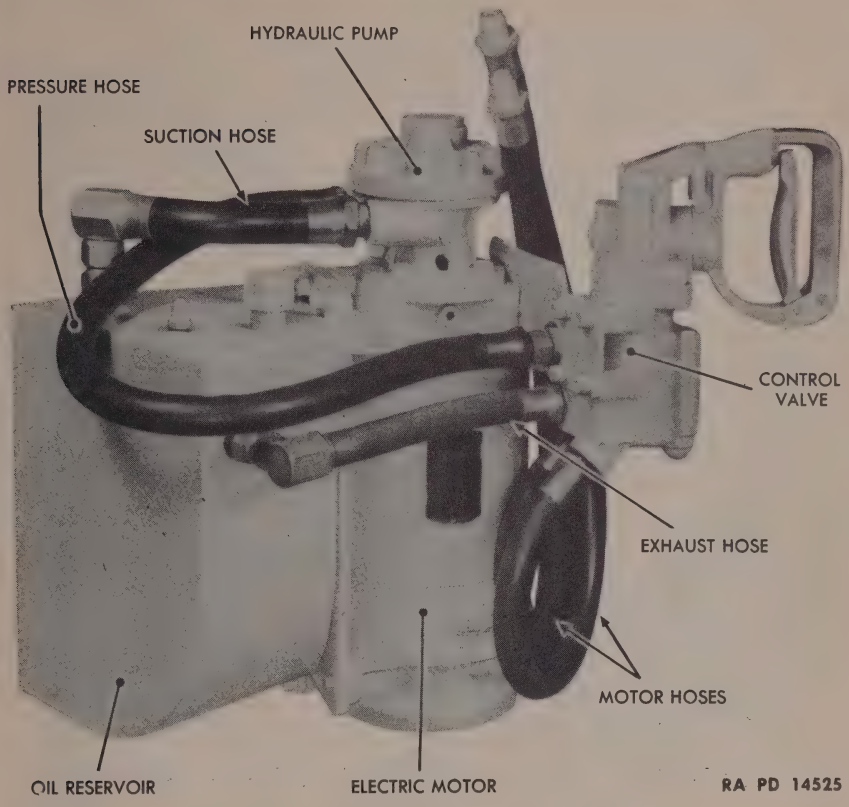

Figure 178—Lower Assembly Removed from Tank—Hydraulic Turret Traversing Mechanism

190. INSTALL CONTROL VALVE.

a. Equipment.

WRENCH, Allen, $\frac{5}{16}$-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, $1\frac{1}{8}$-in.
WRENCH, open-end, $1\frac{3}{16}$-in.
WRENCH, open-end, $1\frac{1}{2}$-in.

b. Procedure.

(1) INSTALL CONTROL VALVE ON BRACKET (fig. 179).

WRENCH, Allen, $\frac{5}{16}$-in.

Hold control valve in position against bracket with handle end of valve up while starting the four socket-head screws that hold valve to bracket. Tighten screws with $\frac{5}{16}$-inch Allen wrench.

(2) CONNECT PRESSURE HOSE (fig. 178).

WRENCH, open-end, 1-in.

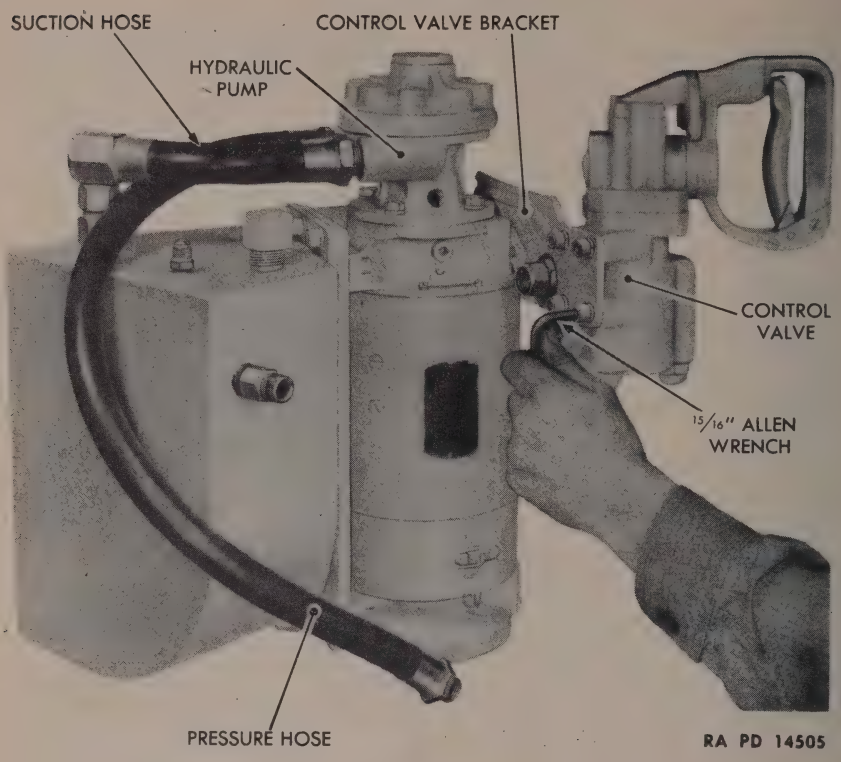

Figure 179—Removing Control Valve from Bracket—Hydraulic Turret Traversing Mechanism

Install pressure hose on connector in control valve. Tighten with 1-inch open-end wrench.

(3) INSTALL EXHAUST HOSE (fig. 178).

WRENCH, open-end, 1⅛-in. **WRENCH**, open-end, $1\frac{3}{16}$-in.

Install exhaust hose in port in control valve, using $1\frac{3}{16}$-inch open-end wrench. Install exhaust hose to connector in oil reservoir, using 1⅛-inch open-end wrench.

(4) CONNECT MOTOR HOSES (fig. 178).

WRENCH, open-end, 1½-in.

Start motor hoses into lower ports in control valve. Tighten with 1½-inch open-end wrench.

HYDRAULIC TRAVERSING MECHANISM

191. REMOVE HYDRAULIC PUMP.

a. Equipment.

WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 3/16-in.
WRENCH, open-end, 1 1/4-in.
WRENCH, open-end, 1 1/2-in.

b. Procedure.

(1) REMOVE PRESSURE HOSE.

WRENCH, open-end, 1-in.
WRENCH, open-end, 1 1/4-in.

Disconnect pressure hose from control valve, using 1-inch open-end wrench. Remove hose from hydraulic pump with 1 1/4-inch open-end wrench.

(2) REMOVE SUCTION HOSE.

WRENCH, open-end, 1 3/16-in.
WRENCH, open-end, 1 1/2-in.

Disconnect suction hose at oil reservoir, using 1 3/16-inch open-end wrench. Remove suction hose from pump with 1 1/2-inch open-end wrench.

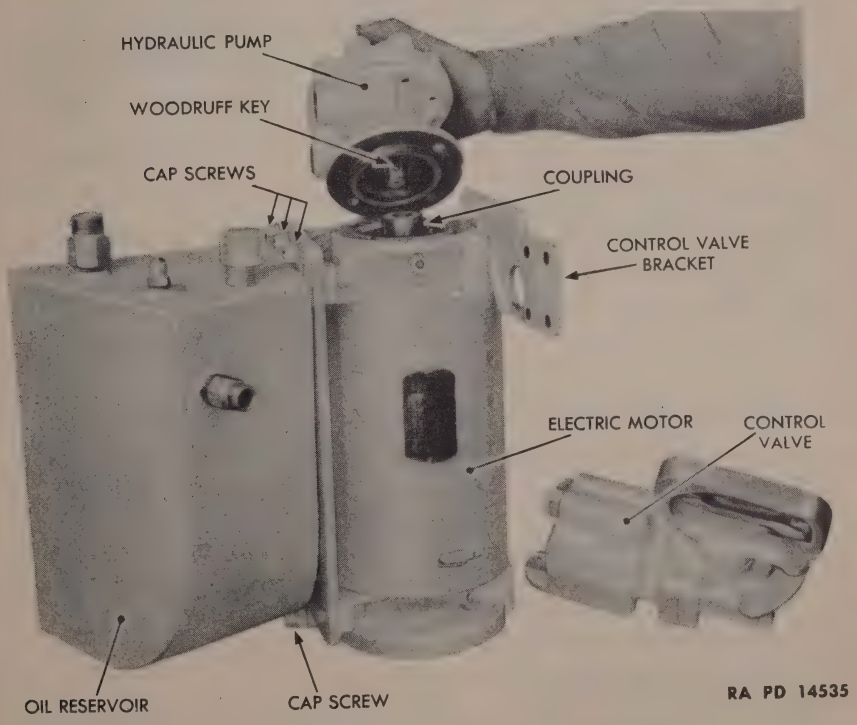

Figure 180—Removing Hydraulic Pump from Electric Motor—Hydraulic Turret Traversing Mechanism

(3) REMOVE PUMP (fig. 180).
WRENCH, open-end, 9/16-in.

With 9/16-inch open-end wrench, remove the four cap screws that hold hydraulic pump to electric motor. Lift off pump and remove Woodruff key from pump shaft.

192. INSTALL HYDRAULIC PUMP.

a. Equipment.

WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1-in.
WRENCH, open-end, 1 3/16-in.
WRENCH, open-end, 1¼-in.
WRENCH, open-end, 1½-in.

b. Procedure.

(1) INSTALL PUMP ON ELECTRIC MOTOR.
WRENCH, open-end, 9/16-in.

Insert Woodruff key in slot in pump shaft. Insert shaft in bore of coupling gear with key engaged in slot in gear. Install the four cap screws and tighten with 9/16-inch open-end wrench.

(2) INSTALL SUCTION HOSE (fig. 178).
WRENCH, open-end, 1 3/16-in.
WRENCH, open-end, 1½-in.

Install suction hose in right pump port, using 1½-inch open-end wrench. Install suction hose on fitting on oil reservoir, using 1 3/16-inch open-end wrench.

(3) INSTALL PRESSURE HOSE.
WRENCH, open-end, 1¼-in.

Using 1¼-inch open-end wrench, install pressure hose in left port of pump. Install other end of pressure hose on fitting in control valve. Pressure hose crosses under suction hose when correctly installed (fig. 178).

193. REMOVE ELECTRIC MOTOR.

a. Equipment.

WRENCH, Allen, 5/16-in.

b. Procedure.

(1) REMOVE LOWER ASSEMBLY (par. 188).
(2) REMOVE CONTROL VALVE (par. 189).
(3) REMOVE PUMP (par. 191).
(4) REMOVE OIL RESERVOIR (fig. 181).
WRENCH, Allen, 5/16-in.

Using 5/16-inch Allen wrench, remove the four cap screws that hold reservoir to electric motor. Cap screw not shown in figure 181 is at bottom right rear of reservoir.

HYDRAULIC TRAVERSING MECHANISM

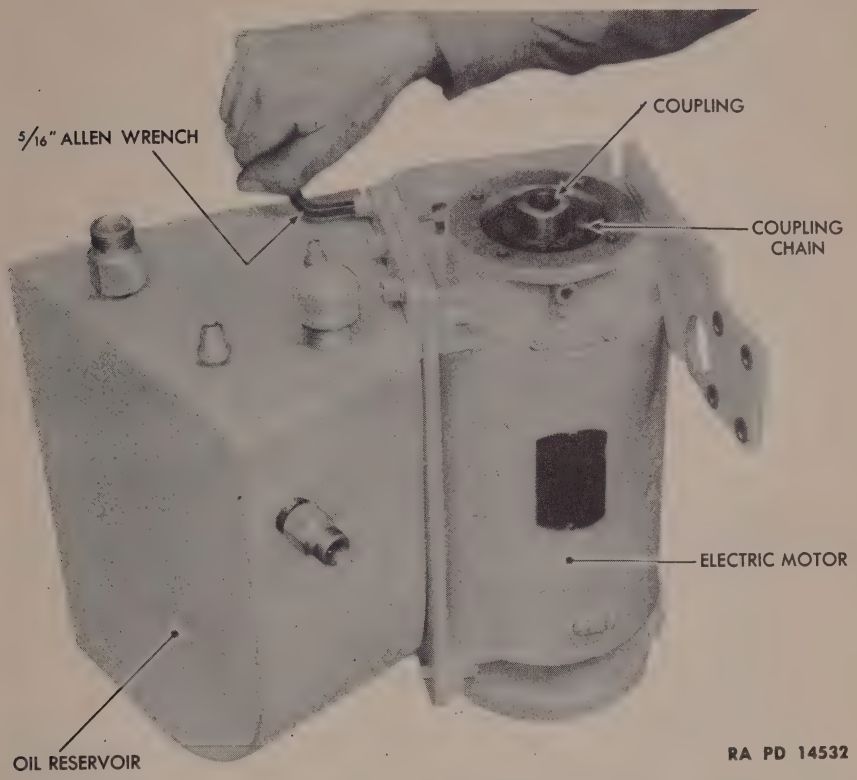

Figure 181—Removing Oil Reservoir from Electric Motor—Hydraulic Turret Traversing Mechanism

194. INSTALL ELECTRIC MOTOR.

a. Equipment.

WRENCH, Allen, 5/16-in.

b. Procedure.

(1) ASSEMBLE ELECTRIC MOTOR WITH OIL RESERVOIR.

WRENCH, Allen, 5/16-in.

Install the three upper and one lower cap screws that hold oil reservoir to electric motor. Tighten with 5/16-inch Allen wrench.

(2) INSTALL PUMP ON MOTOR (par. 192).

(3) INSTALL CONTROL VALVE (par. 190).

(4) INSTALL LOWER ASSEMBLY (par. 197).

195. REMOVE OIL RESERVOIR.

a. Equipment.

WRENCH, Allen, 5/16-in.

WRENCH, open-end, 1-in.

WRENCH, open-end, 1 3/16-in.

b. Procedure.

(1) DISCONNECT SUCTION HOSE.

WRENCH, open-end, $1\frac{3}{16}$-in.

Using $1\frac{3}{16}$-inch open-end wrench, disconnect suction hose from fitting on top of oil reservoir.

(2) DISCONNECT EXHAUST HOSE.

WRENCH, open-end, 1-in.

Using 1-inch open-end wrench, disconnect exhaust hose from fitting on front of oil reservoir.

(3) REMOVE RESERVOIR FROM MOTOR.

WRENCH, Allen, $\frac{5}{16}$-in.

Remove the three upper and one lower cap screws that hold reservoir to electric motor. Remove reservoir.

196. INSTALL OIL RESERVOIR.

a. Equipment.

WRENCH, Allen, $\frac{5}{16}$-in.
WRENCH, open-end, $1\frac{3}{16}$-in.
WRENCH, open-end, 1-in.

b. Procedure.

(1) INSTALL RESERVOIR ON MOTOR.

WRENCH, Allen, $\frac{5}{16}$-in.

Install reservoir on electric motor with three upper and one lower cap screws, using $\frac{5}{16}$-inch Allen wrench.

(2) INSTALL EXHAUST HOSE.

WRENCH, open-end, 1-in.

Using 1-inch open-end wrench, install exhaust hose on fitting on front of reservoir.

(3) INSTALL SUCTION HOSE.

WRENCH, open-end, $1\frac{3}{16}$-in.

Using $1\frac{3}{16}$-inch open-end wrench, install suction hose on fitting in top of reservoir.

197. INSTALL LOWER ASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, Allen, $\frac{3}{8}$-in.
WRENCH, box, $\frac{7}{16}$-in.
WRENCH, open-end, $1\frac{1}{16}$-in.
WRENCH, open-end, $\frac{3}{4}$-in.

b. Procedure.

(1) INSTALL ELECTRIC MOTOR ASSEMBLY.

WRENCH, Allen, $\frac{3}{8}$-in.

With one man holding the assembly (electric motor, pump, oil reser-

voir and control valve) in place from inside basket, install and tighten first the two upper, then two lower socket-head screws from outside basket. Use 3/8-inch Allen wrench.

(2) INSTALL MOTOR DRAIN TUBE (par. 187 b (5)).

(3) INSTALL MOTOR TUBES (par. 187 b (4)).

(4) INSTALL BREATHER TUBE.

SCREWDRIVER
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 1 1/16-in.

Start breather tube onto fitting on top of reservoir and tighten with 3/4-inch open-end wrench. Tighten lock nut with 1 1/16-inch open-end wrench. Install breather tube clip cover tube on wall of turret with screwdriver.

(5) CONNECT STABILIZER PUMP.

WRENCH, box, 7/16-in.

Connect stabilizer pump to lower end of electric motor with four cap screws and lock washers, using 7/16-inch box wrench.

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Section XXVII

TURRET AND HULL

	Paragraph
Turret cal. .30 machine gun	198
Inspections after combat	199
Turret hatch ring	200
Hatch covers and pistol port cover	201
Escape hatch	202

198. TURRET CAL. .30 MACHINE GUN.

a. General.

Since the cal. .30 machine gun mounted in the turret is fired electrically, by means of a firing solenoid, special procedure must be used in dismounting and remounting the gun.

b. Dismounting the Gun (fig. 136).

(1) Unscrew the set screw in the solenoid bracket.

(2) Pull the rear trunnion pin, releasing the solenoid. Handle the solenoid carefully in setting it up out of the way.

(3) Remove the front pinion and lift out the gun.

(4) Replace the solenoid on the mount, install the set screw and replace the rear trunnion, locking the solenoid in place.

c. Mounting the Gun (fig. 136).

(1) Remove the rear trunnion pin and move the solenoid to one side.

(2) Remove the front trunnion pin and set the gun in place. Reinstall the front trunnion pin.

(3) Unscrew the solenoid set screw until it is flush with the top of the bracket.

(4) Install the solenoid in place underneath the machine gun and lock it in position with the rear trunnion pin.

(5) Screw the set screw up against the floor plate of the machine gun.

d. Testing Solenoid Firing of Gun.

(1) TEST FOR RUNAWAY GUN AS FOLLOWS:

(a) Pull the bolt to the rear and release.

(b) Squeeze the trigger, and listen for the impact of the firing pin. If the firing pin goes forward, the solenoid adjustment is correct to prevent a runaway gun. If the sear did not engage the firing pin to hold it in firing position, the solenoid must be adjusted as outlined in (c).

(c) Unscrew the lock nut on the plunger arm (fig. 136) and turn the plunger clockwise. This will lengthen the plunger arm, thus pushing

the lower arm of the link to the rear and pulling the upper arm and finger down, away from the machine gun trigger.

(d) Test action again, by cocking gun and squeezing trigger. If firing pin moves forward, tighten the lock nut on the plunger.

(2) TEST TO SEE IF GUN IS FIRED BY SOLENOID.

(a) Cock the machine gun and close the firing switch, operating the solenoid.

(b) Check to see if the gun has fired by pulling the machine gun trigger. If the firing pin has gone forward, the adjustment is correct. If the firing pin fails to go forward, the solenoid adjustment must be changed as indicated in following step *(c)*.

(c) Unscrew the lock nut on the plunger arm and turn the plunger counterclockwise. This will shorten the plunger arm, thus pulling the lower arm of the link towards the front and pushing the upper arm and finger up toward the machine gun trigger.

(d) Test by operating the solenoid and checking as in step *(b)*. Also check for runaway gun, as in (1). If adjustment is correct, tighten lock nut.

199. INSPECTIONS AFTER COMBAT.

a. Ordinarily the turret and hull will require little attention other than careful checking to see that all parts are tight and that hinges and other moving parts are properly lubricated. The turret race should be regularly lubricated with a grease gun at the two fittings on the inner turret ring. After the tank has been in combat, however, special inspections should be made.

b. Inspections.

(1) Check hull and turret, inside and out, for evidences of cracks or damage from fire.

(2) Remove debris or bullet splash from turret race, from under turret hatch ring, and from behind gun shields.

(3) Check complete 360-degree traverse of turret, using hand traversing wheel, to determine any obstruction or restricted movement.

(4) Check complete 360-degree traverse of turret hatch ring. To replace hatch cover ring see paragraph 200 **b** and **c**.

(5) Inspect all periscope mounts for presence and condition of covers, and free action of elevation and rotation.

(6) Elevate and depress the 75-mm gun to its full extent of travel, using the manual control to determine any restriction of movement.

(7) Inspect direct vision slots and covers.

(8) Test all hatch covers and pistol port for free operation and correct closing and locking.

(9) Inspect and clean out ventilators.

200. TURRET HATCH RING.

a. Because the turret hatch ring acts as an antiaircraft gun mount it is essential that it always rotate freely and easily. If restriction of movement develops and no external cause can be discovered, the ring and cover assembly should be removed and inspected, and, if necessary, replaced.

b. Removal of Turret Hatch Ring.

SCREWDRIVER, socket, heavy-duty, or
SCREWDRIVER, socket, drag link, and handle
WOOD for supports
WRENCH, socket, $^{9}/_{16}$-in.

(1) Remove all but the two opposite cap screws ($^{9}/_{16}$-in. socket wrench) that hold the retaining ring and the lower half of the inside race to the upper half of the inside race. This is part of the turret hatch ring.

(2) Before removing the last two cap screws from the retaining ring, provide some means of supporting the ring so that it will not drop down and release all the ball bearings from the race. Three wooden supports (fig. 182) can be bolted into place on the left side of the ring, installing the bolts into the lower ends of the tapped holes for the outer race retaining bolts.

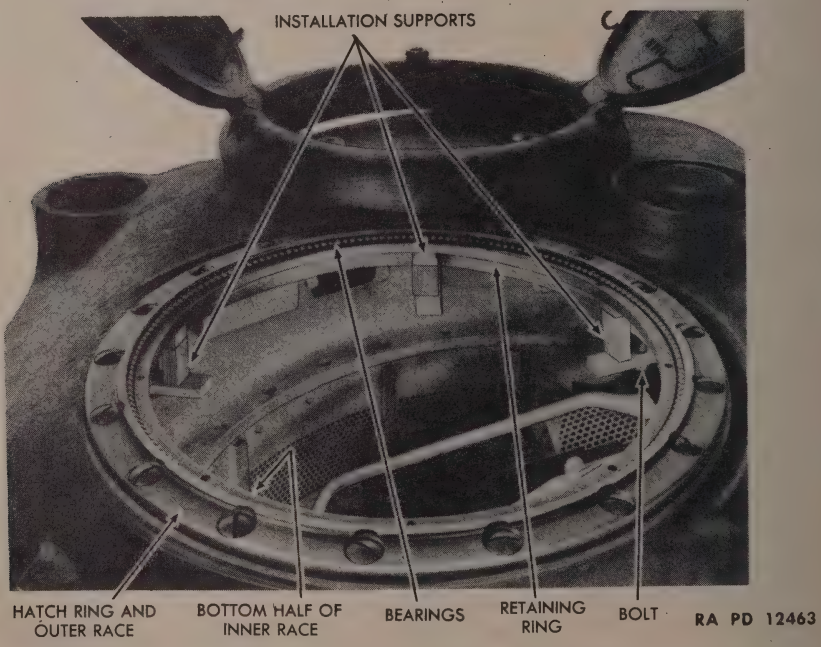

Figure 182—Method of Supporting Inner Race While Removing Hatch Ring

(3) Remove the two remaining cap screws from the retaining ring. Using two men, lift off the ring and cover assembly.

(4) If lower half of inner race has been damaged, remove ball bearings and lift out race.

(5) If outer race has been damaged, remove the 18 screws (heavy-duty socket screwdriver, or socket screwdriver, drag link and handle) and remove the race.

c. Installation of Turret Hatch Ring.

SCREWDRIVER, socket, heavy-duty
SCREWDRIVER, socket, drag link, and handle
WRENCH, socket, $^{9}/_{16}$-in.

(1) If outer race was removed, install in place and install and tighten the 18 screws, pulling them down gradually in rotation to seat the ring evenly (heavy-duty socket screwdriver, or socket screwdriver, drag link, and handle).

(2) Set retaining ring and lower half of inner race in place on supports and install and pack ball bearings.

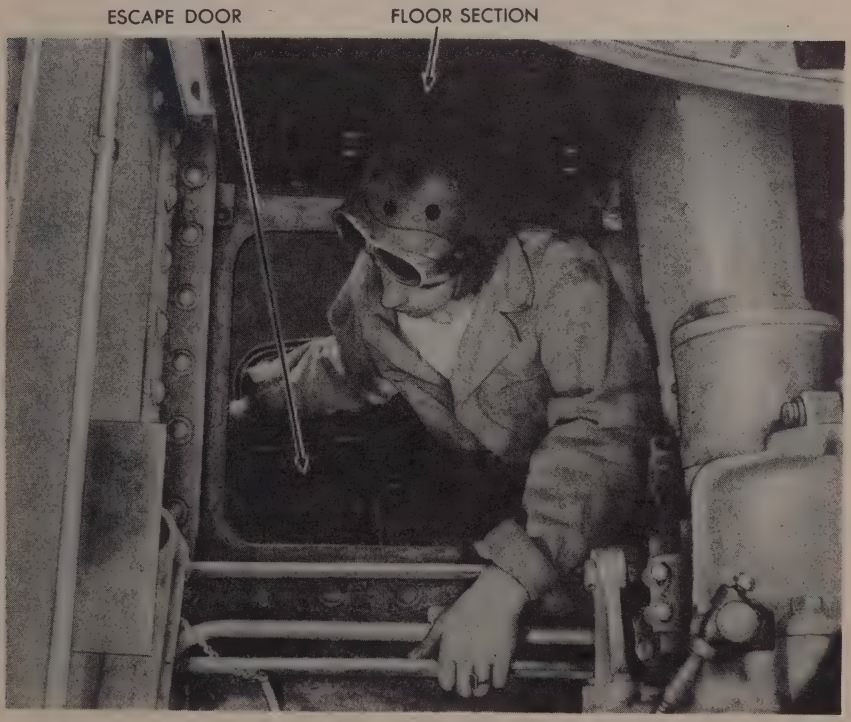

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Figure 183—Leaving Tank through Escape Hatch

(3) Set the turret hatch ring and covers in place (2 men). Line up bolt holes in retaining ring, race, and turret hatch ring and install and tighten the cap screws ($\frac{9}{16}$-in. socket wrench).

(4) Remove the supports.

201. HATCH COVERS AND PISTOL PORT COVER.

a. It is important that all hatch covers and the pistol port cover close tightly and latch easily. Damaged covers should be repaired or replaced immediately. To remove covers, it is necessary only to drive out hinge pin. If the periscope mount is undamaged, it should be removed before removing the hatch cover. Always replace any worn or torn gaskets so that covers will be weather tight when closed.

202. ESCAPE HATCH (figs. 183 and 184).

a. The escape hatch is an important safeguard for members of the crew and should be checked frequently for easy and correct operation. It should be removed, cleaned of dirt and rust, and its working parts lubricated at regular intervals.

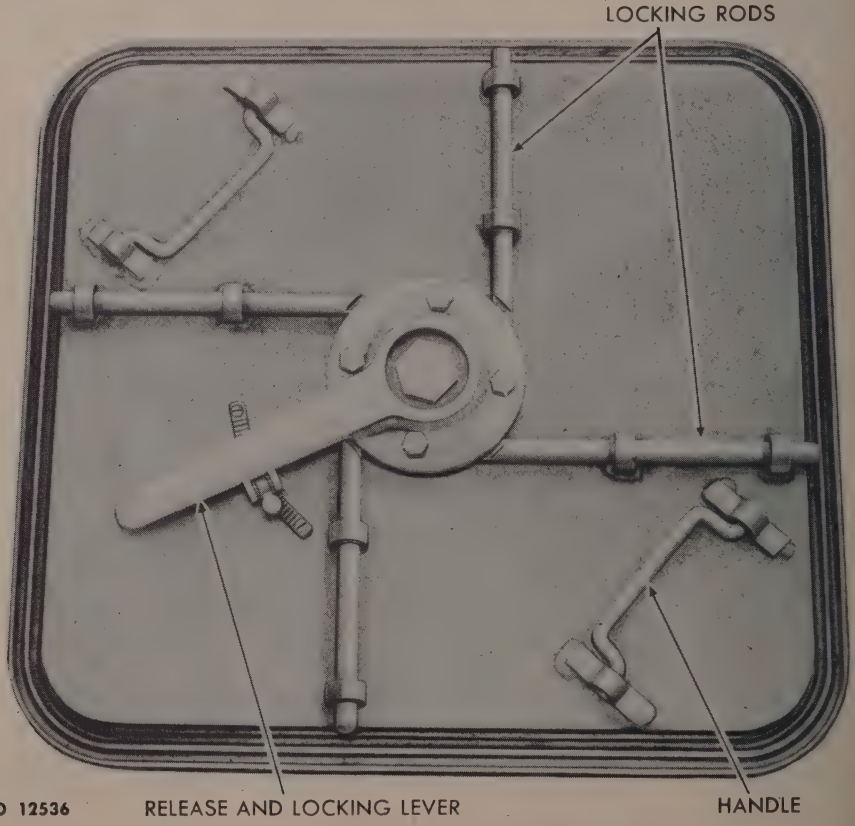

Figure 184—Escape Hatch Cover

Section XXVIII

PAINTING

	Paragraph
General	203
Preparing for painting	204
Painting metal surfaces	205
Paint as a camouflage	206
Removing paint	207
Painting lubricating devices	208

203. GENERAL.

a. Ordnance materiel is painted before issue to the using arms and one maintenance coat per year will ordinarily be ample for protection. With but few exceptions, this materiel will be painted with ENAMEL, synthetic, olive-drab lusterless. The enamel may be applied over old coats of long oil enamel and oil paint previously issued by the Ordnance Department if the old coat is in satisfactory condition for repainting.

b. Paints and enamels are usually issued ready for use and are applied by brush or spray. They may be brushed on satisfactorily when used unthinned in the original package consistency or when thinned no more than 5 percent by volume with THINNER. The enamel will spray satisfactorily when thinned with 15 percent by volume of THINNER. (Linseed oil must not be used as a thinner since it will impart a luster not desired in this enamel.) If sprayed, it dries hard enough for repainting within ½ hour and dries hard in 16 hours.

c. Certain exceptions to the regulations concerning painting exist. Fire-control instruments, sighting equipment, and other items which require a crystalline finish will not be painted with olive-drab enamel.

d. Complete information on painting is contained in TM 9-850.

204. PREPARING FOR PAINTING.

a. If the base coat on the materiel is in poor condition, it is more desirable to strip the old paint from the surface than to use sanding and touchup methods. After stripping, it will then be necessary to apply a primer coat.

b. PRIMER, ground, synthetic, should be used on wood as a base coat for synthetic enamel. It may be applied either by brushing or spraying. It will brush satisfactorily as received or after the addition of not more than 5 percent by volume of THINNER. It will be dry enough to touch in 30 minutes, and hard in 5 to 7 hours. For spraying, it may be

thinned with not more than 15 percent by volume of THINNER. Lacquers must not be applied to the PRIMER, ground, synthetic, within less than 48 hours.

c. PRIMER, synthetic, rust-inhibiting, for bare metal, should be used on metal as a base coat. Its use and application are similar to those outlined in paragraph b above.

d. The success of a job of painting depends not only on the selection of a suitable paint, but also upon the care used in preparing the surface prior to painting. All parts to be painted should be free from rust, dirt, grease, kerosene, oil, and alkali, and must be dry.

205. PAINTING METAL SURFACES.

a. If metal parts are in need of cleaning, they should be washed in a liquid solution consisting of ½ pound of SODA ASH in eight quarts of warm water, or an equivalent solution, then, rinsed in clear water and wiped thoroughly dry. Wood parts in need of cleaning should be treated in the same manner, but the alkaline solution must not be left on for more than a few minutes and the surfaces should be wiped dry as soon as they are washed clean. When artillery or automotive equipment is in fair condition and only marred in spots, the bad places should be touched with ENAMEL, synthetic, olive-drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with PAPER, flint, No. 1, and a finish coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used. If the equiment is in bad condition, all parts should be thoroughly sanded with PAPER, flint, No. 2, or equivalent, given a coat of PRIMER, ground, synthetic, and permited to dry for at least 16 hours. They will then be sandpapered with PAPER, flint, No. 00, wiped free from dust and dirt, and a final coat of ENAMEL, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the materiel is used.

206. PAINT AS A CAMOUFLAGE.

a. Camouflage is now a major consideration in painting ordnance vehicles, with rust prevention secondary. The camouflage plan employed at present utilizes three factors: Color, gloss and stenciling.

(1) COLOR. Vehicles are painted with ENAMEL, synthetic, olive-drab, lusterless, which was chosen to blend in reasonably well with the average landscape.

(2) GLOSS. The new lusterless enamel makes a vehicle difficult to see from the air or from relatively great distances over land. A vehicle painted with ordinary glossy paint can be detected more easily and at greater distances.

(3) STENCILING. White stencil numbers on vehicles have been eliminated because they can be photographed from the air. A blue-drab stencil enamel is now used which cannot be so photographed. It is illegible to the eye at distances exceeding 75 feet.

b. Preserving Camouflage.

(1) Continued friction or rubbing must be avoided, as it will smooth the surface and produce a gloss. The vehicle should not be washed more than once a week. Care should be taken to see that the washing is done entirely with a sponge or a soft rag. The surface should never be rubbed or wiped, except while wet, or a gloss will develop.

(2) It is not desirable that vehicles, painted with lusterless enamel, be kept as clean as vehicles were kept when glossy paint was used. A small amount of dust increases the camouflage value. Grease spots should be removed with SOLVENT, dry-cleaning. Whatever portion of the spot cannot be so removed should be allowed to remain.

(3) Continued friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss, which should be removed with SOLVENT, dry-cleaning.

(4) Tests indicate that repainting with olive-drab paint will be necessary once yearly, with blue-drab paint twice yearly.

207. REMOVING PAINT.

a. After repeated paintings, the paint may become so thick as to crack and scale off in places, presenting an unsightly appearance. If such is the case, remove the old paint by use of a lime-and-lye solution (see TM 9-850 for details) or REMOVER, paint and varnish. It is important that every trace of lye or other paint remover be completely rinsed off and that the equipment be perfectly dry before repainting is attempted. It is preferable that the use of lye solutions be limited to iron or steel parts. If used on wood, the lye solution must not be allowed to remain on the surface for more than a minute before being thoroughly rinsed off and the surface wiped dry with rags. Crevices or cracks in wood should be filled with putty and the wood sandpapered before refinishing. The surfaces thus prepared should be painted according to directions in paragraph 205.

208. PAINTING LUBRICATING DEVICES.

a. Oil cups, grease fittings, oil holes, and similar lubricating devices, as well as a circle about three-fourths of an inch in diameter at each point of lubrication, will be painted with ENAMEL, red, water-resisting, in order that they may be readily located.

MEDIUM TANKS M4 AND M4A1

Section XXIX

PREPARATION FOR SHIPMENT AND STORAGE

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209. SHIPMENT.

a. When shipping the Medium Tanks M4 and M4A1 by rail on flat cars, every precaution must be taken to have each tank properly fastened and blocked to the floor of the car.

b. Cars must be inspected to see if they are in a suitable condition to carry the load safely to its destination. The weight of the tank, approximately 30 tons, makes it most necessary that the cars have good sound floors. All loose nails or other projections not an integral part of the car, other than the prescribed blocking, must be removed. Loose nails, bolts, etc., necessary in car construction, should be made tight rather than removed.

c. The load must be so distributed that there will not be more weight on one side of the car than on the other. If a single tank is placed on a car, it must be so located that one truck of the carrying car does not carry more than one-half of the load weight. All doors and other openings should be closed and securely fastened as a protection against weather and pilfering of equipment. Material used for blocking must be of hardwood, fir, spruce, or long leaf yellow pine, straight grain and free from strength impairing knots.

d. If the vehicle is to be used immediately upon reaching its destination, it may be desirable to keep the fuel tanks filled. If transportation of the tank is by rail express, in which case civilian passengers may be carried in coaches of the same train, the fuel tanks must be drained. The draining of the fuel tanks is not required if only military personnel is carried in accompanying coaches.

e. The hand brake should be applied as soon as the tank is properly located on the car top. There must be at least 6-inch clearance in back, on both sides, of and above the hand brake.

f. Equipment moving from manufacturer to arsenal or proving ground, or from arsenal or proving ground to army post, or individual units moving from one army post to another *must* be placarded "DO NOT HUMP."

g. Further details on loading are to be found in "Special Supplement Containing Rules Governing the Loading of Mechanized and Motorized Army Equipment, also, Major Caliber Guns for the United States Army and Navy, on Open-Top Equipment," published by the Association of American Railroads, Operations and Maintenance Department, April 1, 1941. FM 101-10 also gives information on shipping instructions.

h. Before fastening the tank to the car, it will be necessary to take certain measures to prevent corrosion during transit. If the vehicle is to be in transit for a period of not more than 30 days, it will be permissible to prepare it by operating the engine for a minimum period of one hour, on unleaded "white" gasoline. However, if it is at all practicable, spraying of the interior of the engine with COMPOUND, corrosion-preventive, aircraft engine, according to the methods outlined in AR 850-18 is desirable. In the Medium Tanks M4 and M4A1, this will not be possible without first removing the engine. If the vehicle is to be put in dead storage after it reaches its destination, the engine should be removed and shipped separately in order that corrosion-preventive treatment can be applied immediately before shipment and shortly after it reaches its destination and is placed in dead storage. Due to the corrosive nature of the high octane gasoline ordinarily used in the tank engine, it is most necessary that the above-mentioned, corrosion-preventive measures be taken. Failure to do so will result in serious damage by corrosion. The following paragraph on "Preparation for Storage" will outline the methods of applying corrosion-preventive compounds.

210. PREPARATION FOR STORAGE.

a. General Instructions. The storage of motor vehicles and equipment and inspection in connection therewith are covered in AR850-18. With a few exceptions, the information given in this manual will apply directly to storage and the preparation for storage of the Medium Tanks M4 and M4A1. It will not be practicable in many cases to apply the internal corrosion-preventive treatment to the M4 and M4A1 Tanks prior to limited storage because of the difficulty in removing spark plugs and spraying the interiors of cylinders and other parts while the engine is in the tank. Insofar as it is possible to do so, methods outlined in AR 850-18 must be followed in order that engines and other portions of the materiel are properly protected from damage by corrosion; for dead storage engines must be removed from the tank, inspected, reconditioned if necessary, and then given the proper corrosion-preventive treatment and stored separately.

b. Storage Conditions. Tanks which are not in actual use will be stored in closed buildings or covered sheds if available. In lieu of this preferred storage space, they may be stored in the open and covered

with tarpaulins. In each case, the floor must be solid and free from crushed rock, deep dust, and oil surfacing. It is desirable that the rubber tracks rest on planks. Every precaution must be taken to afford proper drainage of water from the floor and to locate the place of storage so that the materiel will be properly protected from flood or fire.

c. Technical Inspections. The tanks and equipment will be inspected at the time they are placed in storage and at frequent periods as designated in AR 850-18. A tag or tags tied to the unit or vehicle will be kept up to date by the inspector, indicating the condition and work to be done before the unit is again placed in service. Minor work of surface preservation and application of corrosion-preventives will be accomplished at the time of inspection. Work involving the use of shop facilities will be accomplished at the earliest practicable date. Batteries should be removed when a vehicle is placed in dead storage and the battery placed in active stock if practicable.

d. Limited Storage. Vehicles in limited storage are those that are out of service for less than 30 days. Vehicles stored under this heading will be ready for immediate service, and the fuel tanks and oil tanks will be kept filled. The battery will be maintained in a fully charged condition and should remain in the tank. The battery switch and radio switch will be open during storage periods. The vehicle must be thoroughly cleaned and lubricated before being placed in limited storage, and proper precautions should be taken to protect the rubber elements from extreme light or heat. Brakes will not be left applied and vehicle will not be left in gear.

e. Placing Vehicles in Dead Storage. Vehicles in dead storage are those that will not be required for service for an indefinite period. Vehicles should not be in limited storage status for over 30 days, however, it will be impossible to rigidly adhere to this ruling under certain combat conditions. When the Medium Tanks M4 and M4A1 are placed in dead storage, the engine of each tank will be removed, inspected, repaired at once if practicable, and treated with corrosion-preventive compounds. In any event, it is most essential that the treatment with corrosion-preventive compounds be given immediately after the engine is placed in dead storage.

(1) ENGINE VALVE COMPARTMENT. Remove the rocker box covers and spray the valve mechanism with OIL, lubricating, preservative, medium. Special spraying outfits are available for applying this compound. The engine crankshaft will be rotated while the corrosion-preventive compound is applied in such a manner as to thoroughly cover the entire surface of cams and protruding ends of valve stems.

PREPARATION FOR SHIPMENT AND STORAGE

(2) CYLINDERS. The cylinder walls, piston heads, and valves will be treated with OIL, lubricating, preservative, medium. The engine shall be set with the crankshaft extending vertically upward, with the piston of the cylinder being sprayed placed on bottom center of the suction stroke. Each cylinder shall be sprayed through the spark plug or injector hole, taking care not to damage the threads during the spraying operation. The quantity of compound to be sprayed into each cylinder will be metered, if possible; if meters are not available, measurement will be accomplished by accurately determining the time required to spray the specific quantities and timing subsequent spraying of the individual cylinders to obtain the proper quantity in each. Personnel first performing the spraying operation shall determine by experiment the proper technique for completely coating cylinder wall, piston head, and valves with corrosion-preventive compound. Two ounces of compound will be sprayed into each cylinder, after which the engine crankshaft will be revolved at least two complete revolutions. The cylinder space above each piston will then be resprayed with one ounce of compound without revolving the crankshaft further, since this space is particularly susceptible to corrosion. This procedure permits treatment of the maximum surface of the cylinder wall and the piston head. The intake valve will be open sufficiently to permit a small quantity of the vaporized corrosion-preventive compound to reach the valve face. After thus treating the interior of all cylinders, a small quantity of the corrosion-preventive compound will be sprayed into each exhaust port, with each exhaust valve in a fully opened position so that it will be coated. If, at any time, the engine to be treated is equipped with exhaust collector rings that are difficult to remove, the exhaust valve must be sprayed through the spark plug hole instead of the exhaust port. However, this must be done with the exhaust valve fully opened and after the inside of the cylinder has been coated as outlined above.

(3) MAGNETOS. Magnetos shall be treated by lightly coating the steel parts with rust-preventive compound, or with petrolatum.

(4) OPENINGS. All fuel and oil lines or open connections, cylinder ports and other openings shall be closed with suitable plugs, covers, etc. Threaded openings shall be closed with threaded plugs whenever practical. If wooden or similar tapered plugs are used, they shall be so constructed that they cannot be accidentally pushed or driven completely into the opening. When necessary, the rear oil tank vent connection plug shall be removed to prevent excess oil in the rear section from draining into the magneto while the engine is standing with the crankshaft in the vertical position. When this plug is removed, it will be wired to the engine as close as possible to the hole from which it was removed.

(5) SPARK PLUGS. Spark plugs will be removed; the spark plug holes will be oiled and then stopped by inserting shipping plugs, unserviceable spark plugs, corks, or wooden plugs. The removed plugs shall be cleaned, adjusted, and tested; if serviceable, the spark plugs shall be coated with corrosion-preventive compound and placed in stock.

(6) EXTERIOR OF ENGINE. The exterior of the engine will be thoroughly cleaned with SOLVENT, dry-cleaning. A coating of rust-preventive compound will be applied on all unpainted steel parts. Rust appearing on any part before storage will be removed with sandpaper or a wire brush and the metal coated with corrosion-preventive compound unless the surface was originally painted. Painted surfaces will be repainted.

(7) GASOLINE. Drain gasoline and return it to proper storage.

(8) BATTERY. Remove the battery from the vehicle. After plugging the vents in the cells, the case shall be cleaned with a solution of SODA ASH and water (8 ounces to the gallon) to neutralize the acid. After this treatment, the case will be flushed with cold water; do not use hot water or steam. Remove plugs from the vents after cleaning. Terminals and cable ends will be thoroughly cleaned with SODA ASH solution, scraping them clean with suitable tool or wire brush, and will then be greased with PETROLATUM or light grease. Hydrometer readings of cells will be taken and the battery charged, if readings are 1225 or less. Distilled water will be added to cover the plates, but not in excess of one-quarter inch above plates. Place the battery in active stock. Never allow batteries in stock to become discharged below a hydrometer reading of 1225; this will be a proper precaution against freezing in all but the most severe weather, when a specific gravity of 1250 shall be maintained.

(9) VEHICLE GENERAL. Rust appearing on any part before storage will be removed with sandpaper. Painted surfaces will be repainted and unpainted surfaces will be lightly coated with rust-preventive compound.

(10) INSPECTION TAG. Attach a tag to the dashboard. The dates of inspections will be entered on this tag and each initialed by the inspector.

f. Periodic Treatment of Vehicles in Dead Storage. At the expiration of each three-month period, corrosion-preventive treatment will be repeated, giving particular attention to the cylinders, valve compartments, and other internal parts. Under unfavorable climatic conditions, such as might occur in tropical climates or near salt water, it will be necessary to perform more frequent inspections and corrosion-preventive treatments in order to prevent damage to the equipment.

g. Check-Up of Vehicles in Dead Storage. Vehicles will be inspected frequently to see that equipment or parts are not removed without proper authority.

h. Removing Vehicles from Dead Storage.

(1) MAGNETOS. Wipe the magnetos with a clean, dry rag to remove excess rust-preventive compound used and assemble magneto to the engine.

(2) CYLINDERS. Remove plugs from spark plug holes and pump out excess rust-preventive compound above the pistons with hand pump, or if pump is not available, turn the engine over by hand to force out the corrosion-preventive compound.

(3) VALVES. Rotate the crankshaft through three or four revolutions by hand and observe for proper operation of valve mechanism. Any valve found to be sticking shall have the stem generously lubricated with penetrating oil or with a 50-50 mixture of kerosene and light lubricating oil. Continue to turn the engine over by hand until all evidence of sticking valves has been eliminated. If this treatment does not free the valves, necessary mechanical repairs to free them must be made before the engine is placed in service.

(4) GASOLINE TANK. Tank should be filled.

(5) SPARK PLUGS. New spark plugs should be installed in the engine.

(6) BATTERY. Install a fully charged battery.

(7) TRANSMISSIONS, TRANSFER CASES, DIFFERENTIALS, AXLE HOUSINGS, ETC. Drain old lubricant from these units and other enclosed gears, flush thoroughly with OIL, engine, SAE 10, and fill them to proper levels with the correct lubricant, using the lubrication section as a guide.

(8) ENGINE OIL TANK. Install the engine in the tank; fill the oil tank about half full (18 quarts). Since the material used as a corrosion-preventive on the interior surfaces of the engine mixes freely with engine oil, it will not be necessary to remove it prior to adding lubricating oil. Run the engine 2 or 3 hours; then, drain the oil tank and add new oil to the system. The second addition of oil will require 36 quarts to properly fill the oil tank.

(9) LUBRICATION. The tank should be thoroughly lubricated before being placed in service.

(10) INSPECTION. A thorough inspection of the vehicle will be made upon the removal from dead storage. Any repairs that have been ordered

on the inspection tag attached when the vehicle entered storage and which have not been previously made, must be taken care of at this time.

(11) STARTING ENGINE. Engine will be started according to the instructions given in section II, paragraph 8. Particular attention should be given to watching for overheating of the engine, excessive vibration, or any unusual noises that may indicate something is wrong. Starting of the tank by coasting or by towing must not be attempted since serious injury to the working parts may result from this practice.

211. STORAGE OF COMPONENTS AND EQUIPMENT.

a. Components removed from vehicles prior to storage must be thoroughly inspected and overhauled, if necessary, before being stored for reissue. These components, including engines, need not be retained in storage for any particular vehicle, but should be considered as stock when issue becomes necessary.

Section XXX

REFERENCES

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212. STANDARD NOMENCLATURE LISTS.

a. Armament.

Gun, machine, cal. .30, Browning, M1919A4, fixed and flexible, and M1919A5 fixed, and ground mounts ..... SNL A-6

Gun, machine, cal. .50, Browning, M2, heavy barrel, fixed and flexible, and ground mounts ..... SNL A-39

Gun, submachine, cal. .45, Thompson, M1928A1 and M1 ..... SNL A-32

b. Cleaning, preserving, and lubricating materials, recoil fluids, special oils, and similar items of issue ..... SNL K-1

c. Tank, medium, M4 ..... SNL G-104

Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" ..... VOL. VI OPSI

213. EXPLANATORY PUBLICATIONS.

a. Armament.

75-mm tank gun materiel, M2 ..... TM 9-307

Browning machine gun, caliber .30, HB, M1919A4 (mounted in combat vehicles) ..... FM 23-50

Browning machine gun, caliber .50, HB, M2 (mounted in combat vehicles) ..... FM 23-65

Browning machine gun, caliber .50, HB, M2, ground ..... FM 23-60

Grenades ..... FM 23-30

Thompson submachine gun, caliber .45, M1928A1 FM 23-40

b. Automotive Materiel.

Automotive brakes ..... TM 10-565

Automotive power transmission units ..... TM 10-585

Chassis, body, and trailer units ..... TM 10-560

The motor vehicle ..... TM 10-510

c. Cleaning, preserving, lubricating and welding materials and similar items issued by the Ordnance Department ..... TM 9-850

d. Communication.

Radio fundamentals ..... TM 11-455
Radio sets SCR-508, SCR-528, and SCR-538 ..... TM 11-600
Radio set SCR-506 ..... TM 11-630
Radio sets SCR-210-series and 245-series ..... TM 11-272
The radio operator ..... TM 11-454

e. Maintenance and Inspection.

Automotive lubrication ..... TM 10-540
Detailed lubrication instructions Ordnance Materiel ..... OFSB 6 series
Echelon system of maintenance ..... TM 10-525
Fire prevention, safety precautions, accidents ..... TM 10-360
Hand, measuring, and power tools ..... TM 10-590
Maintenance and repair ..... TM 10-520
Motor transport inspections ..... TM 10-545
Ordnance Maintenance: Accessories for Wright R975-EC2, engines for medium tanks M3 and M4 (now published as TM 1750D) ..... TM 9-1730D
Ordnance Maintenance: Auxiliary generator (Homelite model HRH-28) for medium tank, M3 (now published as TM 9-1752) ..... TM 9-1730K
Ordnance Maintenance: Electric traversing mechanism, medium tanks M4 and modifications ..... TM 9-1731E
Ordnance Maintenance: Guiberson Diesel T1400 engine series 3, for medium tanks M3 and M4 and related gun motor carriages (now published as TM 9 1750E) ..... TM 9-1730E
Ordnance Maintenance: Gyro control mechanism (confidential) (now published as TM 9-1798B) TM 9-1739B
Ordnance Maintenance: Power train unit, three-piece differential case for medium tanks M3, M4, and modifications (now published as TM 9-1750) ..... TM 9-1730A
Ordnance Maintenance: Stabilizers (now published as TM 9-1798A) ..... TM 9-1739A
Ordnance Maintenance: Wright Whirlwind engine, model R975 EC 2 (now published as TM 9 1751) ..... TM 9-1730C
Tune-up and adjustment ..... TM 10-530

REFERENCES

f. Miscellaneous.

Automotive electricity	TM10-580
Camouflage	FM 5-20
Defense against chemical attack	FM 21-40
Fuels and carburetion	FM 10-550
List of publications for training, including training films and film strips	FM 21-6
Military motor transportation	TM 10-505
Military motor vehicles	AR 850-15
The internal combustion engine	TM 10-570

g. Storage of motor vehicle equipment . . . . . AR 850-18

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[A.G. 062.11 (9-25-42)
O.O. 461/27676 O.O. (11-19-42)]

BY ORDER OF THE SECRETARY OF WAR:

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DISTRIBUTION:

D 17(10); IR 17(6), 9(2); IBn 9(1), 17(4); IC 17(17), 9(4)
(For explanation of symbols, see FM 21-6)

PUBLICATIONS DEPARTMENT, RARITAN ARSENAL.

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